



# **Heliarc® 252 AC/DC and Heliarc® 352 AC/DC SQUARE WAVE POWER SOURCES**



## **Instruction Manual**

This manual provides complete instructions for the following power sources starting with Serial No. TORI541008, November, 1995:

	<b>Heliarc 252 AC/DC Item No.</b>	<b>Heliarc 352 AC/DC Item. No.</b>
ESAB 230(208)/460 Vac, 60 Hz, 1 Phase	*36200	*36210
ESAB 230/460/575 Vac, 60 Hz, 1 Phase	36201	36211
ESAB 220/400(380/415) Vac, 50 Hz, 1 Phase	*36202	*36212
ESAB 220/400(380/415) Vac, 50 Hz, 1 Phase, CE	36205	36207
*ESAB 220/400(380/415) Vac, 60 Hz, 1 Phase	*36849	*36850

\*Manufactured for export services only.

\* = Discontinued

**BE SURE THIS INFORMATION REACHES THE OPERATOR.  
YOU CAN GET EXTRA COPIES THROUGH YOUR SUPPLIER.**



These INSTRUCTIONS are for experienced operators. If you are not fully familiar with the principles of operation and safe practices for arc welding and cutting equipment, we urge you to read our booklet, "Precautions and Safe Practices for Arc Welding, Cutting, and Gouging," Form 52-529. Do NOT permit untrained persons to install, operate, or maintain this equipment. Do NOT attempt to install or operate this equipment until you have read and fully understand these instructions. If you do not fully understand these instructions, contact your supplier for further information. Be sure to read the Safety Precautions before installing or operating this equipment.

## **USER RESPONSIBILITY**

This equipment will perform in conformity with the description thereof contained in this manual and accompanying labels and/or inserts when installed, operated, maintained and repaired in accordance with the instructions provided. This equipment must be checked periodically. Malfunctioning or poorly maintained equipment should not be used. Parts that are broken, missing, worn, distorted or contaminated should be replaced immediately. Should such repair or replacement become necessary, the manufacturer recommends that a telephone or written request for service advice be made to the Authorized Distributor from whom it was purchased.

This equipment or any of its parts should not be altered without the prior written approval of the manufacturer. The user of this equipment shall have the sole responsibility for any malfunction which results from improper use, faulty maintenance, damage, improper repair or alteration by anyone other than the manufacturer or a service facility designated by the manufacturer.

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## TABLE OF CONTENTS

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SECTION PARAGRAPH	TITLE	PAGE
	<b>SAFETY PRECAUTIONS.....</b>	<b>5-10</b>
<b>SECTION 1</b>	<b>DESCRIPTION.....</b>	<b>11</b>
1.1	Introduction .....	11
1.2	Duty Cycle.....	11
<b>SECTION 2</b>	<b>INSTALLATION .....</b>	<b>15</b>
2.1	General .....	15
2.1.1	Unpacking and Placement .....	15
2.2	Primary (Input) Electrical Connection .....	16
2.3	Secondary (Output) Connection .....	20
2.4	Accessories.....	20
<b>SECTION 3</b>	<b>OPERATION .....</b>	<b>23</b>
3.1	Control Function.....	23
3.2	Sequence of Operation .....	27
3.2.1	Stick Electrode/Shielded Metal Arc Welding .....	27
3.2.2	Tig Welding .....	27
<b>SECTION 4</b>	<b>MAINTENANCE.....</b>	<b>31</b>
4.1	Maintenance.....	31
4.1.1	Cleaning .....	31
4.1.2	Lubrication.....	31
4.1.3	Spark Gap Servicing .....	31
4.1.4	Spark Gap Adjustment.....	32
4.1.5	Testing and Replacing Bridge Assembly Components .....	32
4.1.6	Dip Switch Settings of Main Control Board Assembly.....	33
<b>SECTION 5</b>	<b>TROUBLESHOOTING.....</b>	<b>35</b>
5.1	General .....	35
<b>SECTION 6</b>	<b>REPLACEMENT PARTS .....</b>	<b>43</b>
6.1	General .....	43
6.2	Ordering .....	43

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## TABLE OF CONTENTS

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## SAFETY PRECAUTIONS



**WARNING:** These Safety Precautions are for your protection. They summarize precautionary information from the references listed in Additional Safety Information section. Before performing any installation or operating procedures, be sure to read and follow the safety precautions listed below as well as all other manuals, material safety data sheets, labels, etc. Failure to observe Safety Precautions can result in injury or death.



**PROTECT YOURSELF AND OTHERS** -- Some welding, cutting, and gouging processes are noisy and require ear protection. The arc, like the sun, emits ultraviolet (UV) and other radiation and can injure skin and eyes. Hot metal can cause burns. Training in the proper use of the processes and equipment is essential to prevent accidents. Therefore:

1. Always wear safety glasses with side shields in any work area, even if welding helmets, face shields, and goggles are also required.
2. Use a face shield fitted with the correct filter and cover plates to protect your eyes, face, neck, and ears from sparks and rays of the arc when operating or observing operations. Warn bystanders not to watch the arc and not to expose themselves to the rays of the electric-arc or hot metal.
3. Wear flameproof gauntlet type gloves, heavy long-sleeve shirt, cuffless trousers, high-topped shoes, and a welding helmet or cap for hair protection, to protect against arc rays and hot sparks or hot metal. A flameproof apron may also be desirable as protection against radiated heat and sparks.
4. Hot sparks or metal can lodge in rolled up sleeves, trouser cuffs, or pockets. Sleeves and collars should be kept buttoned, and open pockets eliminated from the front of clothing.
5. Protect other personnel from arc rays and hot sparks with a suitable non-flammable partition or curtains.
6. Use goggles over safety glasses when chipping slag or grinding. Chipped slag may be hot and can fly far. Bystanders should also wear goggles over safety glasses.



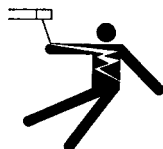
**FIRES AND EXPLOSIONS** -- Heat from flames and arcs can start fires. Hot slag or sparks can also cause fires and explosions. Therefore:

1. Remove all combustible materials well away from the work area or cover the materials with a protective non-flammable covering. Combustible materials include wood, cloth, sawdust, liquid and gas fuels, solvents, paints and coatings, paper, etc.
2. Hot sparks or hot metal can fall through cracks or crevices in floors or wall openings and cause a hidden smoldering fire or fires on the floor below. Make certain that such openings are protected from hot sparks and metal.
3. Do not weld, cut or perform other hot work until the workpiece has been completely cleaned so that there are no substances on the workpiece which might produce flammable or toxic vapors. Do not do hot work on closed containers. They may explode.
4. Have fire extinguishing equipment handy for instant use, such as a garden hose, water pail, sand bucket, or portable fire extinguisher. Be sure you are trained in its use.
5. Do not use equipment beyond its ratings. For example, overloaded welding cable can overheat and create a fire

hazard.

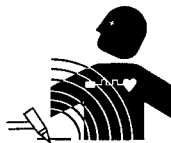
6. After completing operations, inspect the work area to make certain there are no hot sparks or hot metal which could cause a later fire. Use fire watchers when necessary.
7. For additional information, refer to NFPA Standard 51B, "Fire Prevention in Use of Cutting and Welding Processes", available from the National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

**ELECTRICAL SHOCK** -- Contact with live electrical parts and ground can cause severe injury or death. DO NOT use AC welding current in damp areas, if movement is confined, or if there is danger of falling.



1. Be sure the power source frame (chassis) is connected to the ground system of the input power.
2. Connect the workpiece to a good electrical ground.
3. Connect the work cable to the workpiece. A poor or missing connection can expose you or others to a fatal shock.
4. Use well-maintained equipment. Replace worn or damaged cables.
5. Keep everything dry, including clothing, work area, cables, torch/electrode holder, and power source.
6. Make sure that all parts of your body are insulated from work and from ground.
7. Do not stand directly on metal or the earth while working in tight quarters or a damp area; stand on dry boards or an insulating platform and wear rubber-soled shoes.
8. Put on dry, hole-free gloves before turning on the power.
9. Turn off the power before removing your gloves.
10. Refer to ANSI/ASC Standard Z49.1 (listed on next page) for specific grounding recommendations. Do not mistake the work lead for a ground cable.

**ELECTRIC AND MAGNETIC FIELDS** — May be dangerous. Electric current flowing through any conductor causes localized Electric and Magnetic Fields (EMF). Welding and cutting current creates EMF around welding cables and welding machines. Therefore:



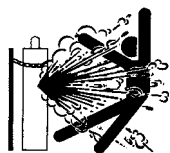
1. Welders having pacemakers should consult their physician before welding. EMF may interfere with some pacemakers.
2. Exposure to EMF may have other health effects which are unknown.
3. Welders should use the following procedures to minimize exposure to EMF:
  - A. Route the electrode and work cables together. Secure them with tape when possible.
  - B. Never coil the torch or work cable around your body.
  - C. Do not place your body between the torch and work cables. Route cables on the same side of your body.
  - D. Connect the work cable to the workpiece as close as possible to the area being welded.
  - E. Keep welding power source and cables as far away from your body as possible.

## SAFETY PRECAUTIONS



**FUMES AND GASES --** Fumes and gases, can cause discomfort or harm, particularly in confined spaces. Do not breathe fumes and gases. Shielding gases can cause asphyxiation. Therefore:

1. Always provide adequate ventilation in the work area by natural or mechanical means. Do not weld, cut, or gouge on materials such as galvanized steel, stainless steel, copper, zinc, lead, beryllium, or cadmium unless positive mechanical ventilation is provided. Do not breathe fumes from these materials.
2. Do not operate near degreasing and spraying operations. The heat or arc rays can react with chlorinated hydrocarbon vapors to form phosgene, a highly toxic gas, and other irritant gases.
3. If you develop momentary eye, nose, or throat irritation while operating, this is an indication that ventilation is not adequate. Stop work and take necessary steps to improve ventilation in the work area. Do not continue to operate if physical discomfort persists.
4. Refer to ANSI/ASC Standard Z49.1 (see listing below) for specific ventilation recommendations.
5. **WARNING: This product, when used for welding or cutting, produces fumes or gases which contain chemicals known to the State of California to cause birth defects and, in some cases, cancer. (California Health & Safety Code §25249.5 et seq.)**



**CYLINDER HANDLING --** Cylinders, if mishandled, can rupture and violently release gas. Sudden rupture of cylinder, valve, or relief device can injure or kill. Therefore:

1. Use the proper gas for the process and use the proper pressure reducing regulator designed to operate from the compressed gas cylinder. Do not use adaptors. Maintain hoses and fittings in good condition. Follow manufacturer's operating instructions for mounting regulator to a compressed gas cylinder.
2. Always secure cylinders in an upright position by chain or strap to suitable hand trucks, undercarriages, benches, walls, post, or racks. Never secure cylinders to work tables or fixtures where they may become part of an electrical circuit.
3. When not in use, keep cylinder valves closed. Have valve protection cap in place if regulator is not connected. Secure and move cylinders by using suitable hand trucks. Avoid rough handling of cylinders.
4. Locate cylinders away from heat, sparks, and flames. Never strike an arc on a cylinder.
5. For additional information, refer to CGA Standard P-1, "Precautions for Safe Handling of Compressed Gases in Cylinders", which is available from Compressed Gas Association, 1235 Jefferson Davis Highway, Arlington, VA 22202.



**EQUIPMENT MAINTENANCE --** Faulty or improperly maintained equipment can cause injury or death. Therefore:

1. Always have qualified personnel perform the installation, troubleshooting, and maintenance work. Do not perform any electrical work unless you are qualified to perform such work.
2. Before performing any maintenance work inside a power source, disconnect the power source from the incoming electrical power.
3. Maintain cables, grounding wire, connections, power cord, and power supply in safe working order. Do not operate any equipment in faulty condition.
4. Do not abuse any equipment or accessories. Keep equipment away from heat sources such as furnaces, wet conditions such as water puddles, oil or grease, corrosive atmospheres and inclement weather.
5. Keep all safety devices and cabinet covers in position and in good repair.
6. Use equipment only for its intended purpose. Do not modify it in any manner.



**ADDITIONAL SAFETY INFORMATION --** For more information on safe practices for electric arc welding and cutting equipment, ask your supplier for a copy of "Precautions and Safe Practices for Arc Welding, Cutting and Gouging", Form 52-529.

The following publications, which are available from the American Welding Society, 550 N.W. LeJuene Road, Miami, FL 33126, are recommended to you:

1. ANSI/ASC Z49.1 - "Safety in Welding and Cutting"
2. AWS C5.1 - "Recommended Practices for Plasma Arc Welding"
3. AWS C5.2 - "Recommended Practices for Plasma Arc Cutting"
4. AWS C5.3 - "Recommended Practices for Air Carbon Arc Gouging and Cutting"
5. AWS C5.5 - "Recommended Practices for Gas Tungsten Arc Welding"
6. AWS C5.6 - "Recommended Practices for Gas Metal Arc Welding"
7. AWS SP - "Safe Practices" - Reprint, Welding Handbook.
8. ANSI/AWS F4.1, "Recommended Safe Practices for Welding and Cutting of Containers That Have Held Hazardous Substances."



**MEANING OF SYMBOLS -** As used throughout this manual: Means Attention! Be Alert! Your safety is involved.



**DANGER**

Means immediate hazards which, if not avoided, will result in immediate, serious personal injury or loss of life.



**WARNING**

Means potential hazards which could result in personal injury or loss of life.



**CAUTION**

Means hazards which could result in minor personal injury.

## PRECAUCION DE SEGURIDAD



**ADVERTENCIA:** Estas Precauciones de Seguridad son para su protección. Ellas hacen resumen de información proveniente de las referencias listadas en la sección "Información Adicional Sobre La Seguridad". Antes de hacer cualquier instalación o procedimiento de operación, asegúrese de leer y seguir las precauciones de seguridad listadas a continuación así como también todo manual, hoja de datos de seguridad del material, calcomanías, etc. El no observar las Precauciones de Seguridad puede resultar en daño a la persona o muerte.



**PROTEJASE USTED Y A LOS DEMAS--** Algunos procesos de soldadura, corte y ranurado son ruidosos y requieren protección para los oídos. El arco, como el sol, emite rayos ultravioleta (UV) y otras radiaciones que pueden dañar la piel y los ojos. El metal caliente causa quemaduras. EL entrenamiento en el uso propio de los equipos y sus procesos es esencial para prevenir accidentes. Por lo tanto:

1. Utilice gafas de seguridad con protección a los lados siempre que esté en el área de trabajo, aún cuando esté usando careta de soldar, protector para su cara u otro tipo de protección.
2. Use una careta que tenga el filtro correcto y lente para proteger sus ojos, cara, cuello, y oídos de las chispas y rayos del arco cuando se esté operando y observando las operaciones. Alerte a todas las personas cercanas de no mirar el arco y no exponerse a los rayos del arco eléctrico o el metal fundido.
3. Use guantes de cuero a prueba de fuego, camisa pesada de mangas largas, pantalón de ruedo liso, zapato alto al tobillo, y careta de soldar con capucha para el pelo, para proteger el cuerpo de los rayos y chispas calientes provenientes del metal fundido. En ocasiones un delantal a prueba de fuego es necesario para protegerse del calor radiado y las chispas.
4. Chispas y partículas de metal caliente puede alojarse en las mangas enrolladas de la camisa, el ruedo del pantalón o los bolsillos. Mangas y cuellos deberán mantenerse abotonados, bolsillos al frente de la camisa deberán ser cerrados o eliminados.
5. Proteja a otras personas de los rayos del arco y chispas calientes con una cortina adecuada no-flamable como división.
6. Use careta protectora además de sus gafas de seguridad cuando esté removiendo escoria o puliendo. La escoria puede estar caliente y desprenderse con velocidad. Personas cercanas deberán usar gafas de seguridad y careta protectora.

**FUEGO Y EXPLOSIONES --** El calor de las flamas y el arco pueden ocasionar fuegos. Escoria caliente y las chispas pueden causar fuegos y explosiones. Por lo tanto:



1. Remueva todo material combustible lejos del área de trabajo o cubra los materiales con una cobija a prueba de fuego. Materiales combustibles incluyen madera, ropa, líquidos y gases inflamables, solventes, pinturas, papel, etc.
2. Chispas y partículas de metal pueden introducirse en las grietas y agujeros de pisos y paredes causando fuegos escondidos en otros niveles o espacios. Asegúrese de que toda grieta y agujero esté cubierto para proteger lugares adyacentes contra fuegos.
3. No corte, suelde o haga cualquier otro trabajo relacionado hasta que la pieza de trabajo esté totalmente limpia y libre de sustancias que puedan producir gases inflamables o vapores tóxicos. No trabaje dentro o fuera de contenedores o tanques cerrados. Estos pueden explotar si contienen vapores inflamables.
4. Tenga siempre a la mano equipo extintor de fuego para uso instantáneo, como por ejemplo una manguera con agua, cubeta con agua, cubeta con arena, o extintor portátil. Asegúrese que usted está entrenado para su uso.
5. No use el equipo fuera de su rango de operación. Por ejemplo, el calor causado por cable sobrecarga en los cables de soldar pueden ocasionar un fuego.

6. Después de terminar la operación del equipo, inspeccione el área de trabajo para cerciorarse de que las chispas o metal caliente ocasionen un fuego más tarde. Tenga personal asignado para vigilar si es necesario.
7. Para información adicional, haga referencia a la publicación NFPA Standard 51B, "Fire Prevention in Use of Cutting and Welding Processes", disponible a través de la National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

**CHOQUE ELECTRICO --** El contacto con las partes eléctricas energizadas y tierra puede causar daño severo o muerte. NO use soldadura de corriente alterna (AC) en áreas húmedas, de movimiento confinado en lugares estrechos o si hay posibilidad de caer al suelo.



1. Asegúrese de que el chasis de la fuente de poder esté conectado a tierra a través del sistema de electricidad primario.
2. Conecte la pieza de trabajo a un buen sistema de tierra física.
3. Conecte el cable de retorno a la pieza de trabajo. Cables y conductores expuestos o con malas conexiones pueden exponer al operador u otras personas a un choque eléctrico fatal.
4. Use el equipo solamente si está en buenas condiciones. Reemplace cables rotos, dañados o con conductores expuestos.
5. Mantenga todo seco, incluyendo su ropa, el área de trabajo, los cables, antorchas, pinza del electrodo, y la fuente de poder.
6. Asegúrese que todas las partes de su cuerpo están aisladas de ambos, la pieza de trabajo y tierra.
7. No se pare directamente sobre metal o tierra mientras trabaja en lugares estrechos o áreas húmedas; trabaje sobre un pedazo de madera seca o una plataforma aislada y use zapatos con suela de goma.
8. Use guantes secos y sin agujeros antes de energizar el equipo.
9. Apague el equipo antes de quitarse sus guantes.
10. Use como referencia la publicación ANSI/ASC Standard Z49.1 (listado en la próxima página) para recomendaciones específicas de como conectar el equipo a tierra. No confunda el cable de soldar a la pieza de trabajo con el cable a tierra.

**CAMPOS ELECTRICOS Y MAGNETICOS -** Son peligrosos. La corriente eléctrica fluye a través de cualquier conductor causando a nivel local Campos Eléctricos y Magnéticos (EMF). Las corrientes en el área de corte y soldadura, crean EMF alrededor de los cables de soldar y las maquinas. Por lo tanto:



1. Soldadores u Operadores que use marca-pasos para el corazón deberán consultar a su médico antes de soldar. El Campo Electromagnético (EMF) puede interferir con algunos marca-pasos.
2. Exponerse a campos electromagnéticos (EMF) puede causar otros efectos de salud aún desconocidos.
3. Los soldadores deberán usar los siguientes procedimientos para minimizar exponerse al EMF:
  - A. Mantenga el electrodo y el cable a la pieza de trabajo juntos, hasta llegar a la pieza que usted quiere soldar. Asegúrelos uno junto al otro con cinta adhesiva cuando sea posible.
  - B. Nunca envuelva los cables de soldar alrededor de su cuerpo.
  - C. Nunca ubique su cuerpo entre la antorcha y el cable, a la pieza de trabajo. Mantenga los cables a un sólo lado de su cuerpo.
  - D. Conecte el cable de trabajo a la pieza de trabajo lo más cercano posible al área de la soldadura.
  - E. Mantenga la fuente de poder y los cables de soldar lo más lejos posible de su cuerpo.

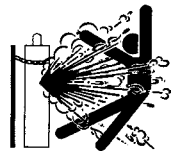
## PRECAUCION DE SEGURIDAD

**HUMO Y GASES** -- El humo y los gases, pueden causar malestar o daño, particularmente en espacios sin ventilación. No inhale el humo o gases. El gas de protección puede causar falta de oxígeno.



**Por lo tanto:**

1. Siempre provea ventilación adecuada en el área de trabajo por medio natural o mecánico. No solde, corte, o ranure materiales con hierro galvanizado, acero inoxidable, cobre, zinc, plomo, berilio, o cadmio a menos que provea ventilación mecánica positiva. No respire los gases producidos por estos materiales.
2. No opere cerca de lugares donde se aplique sustancias químicas en aerosol. El calor de los rayos del arco pueden reaccionar con los vapores de hidrocarburo clorinado para formar un fosfógeno, o gas tóxico, y otros irritantes.
3. Si momentáneamente desarrolla irritación de ojos, nariz o garganta mientras está operando, es indicación de que la ventilación no es apropiada. Pare de trabajar y tome las medidas necesarias para mejorar la ventilación en el área de trabajo. No continúe operando si el malestar físico persiste.
4. Haga referencia a la publicación ANSI/ASC Standard Z49.1 (Vea la lista a continuación) para recomendaciones específicas en la ventilación.
5. **ADVERTENCIA-- Este producto cuando se utiliza para soldaduras o cortes, produce humos o gases, los cuales contienen químicos conocidos por el Estado de California de causar defectos en el nacimiento, o en algunos casos, Cancer. (California Health & Safety Code §25249.5 et seq.)**



**MANEJO DE CILINDROS--** Los cilindros, si no son manejados correctamente, pueden romperse y liberar violentamente gases. Rotura repentina del cilindro, válvula, o válvula de escape puede causar daño o muerte. Por lo tanto:

1. Utilice el gas apropiado para el proceso y utilice un regulador diseñado para operar y reducir la presión del cilindro de gas. No utilice adaptadores. Mantenga las mangueras y las conexiones en buenas condiciones. Observe las instrucciones de operación del fabricante para montar el regulador en el cilindro de gas comprimido.
2. Asegure siempre los cilindros en posición vertical y amárelos con una correa o cadena adecuada para asegurar el cilindro al carro, transportes, tabilleros, paredes, postes, o armazón. Nunca asegure los cilindros a la mesa de trabajo o las piezas que son parte del circuito de soldadura. Este puede ser parte del circuito eléctrico.
3. Cuando el cilindro no está en uso, mantenga la válvula del cilindro cerrada. Ponga el capote de protección sobre la válvula si el regulador no está conectado. Asegure y mueva los cilindros utilizando un carro o transporte adecuado. Evite el manejo brusco de los



**MANTENIMIENTO DEL EQUIPO** -- Equipo defectuoso o mal mantenido puede causar daño o muerte. Por lo tanto:

1. Siempre tenga personal cualificado para efectuar la instalación, diagnóstico, y mantenimiento del equipo. No ejecute ningún trabajo eléctrico a menos que usted esté cualificado para hacer el trabajo.
2. Antes de dar mantenimiento en el interior de la fuente de poder, desconecte la fuente de poder del suministro de electricidad primaria.
3. Mantenga los cables, cable a tierra, conexiones, cable primario, y cualquier otra fuente de poder en buen estado operacional. No opere ningún equipo en malas condiciones.
4. No abuse del equipo y sus accesorios. Mantenga el equipo lejos de cosas que generen calor como hornos, también lugares húmedos como charcos de agua, aceite o grasa, atmósferas corrosivas y las inclemencias del tiempo.
5. Mantenga todos los artículos de seguridad y coverturas del equipo en su posición y en buenas condiciones.
6. Use el equipo sólo para el propósito que fue diseñado. No modifique el equipo en ninguna manera.

### INFORMACION ADICIONAL DE SEGURIDAD

-- Para más información sobre las prácticas de seguridad de los equipos de arco eléctrico para soldar y cortar, pregunte a su suplidor por una copia de "Precautions and Safe Practices for Arc Welding, Cutting and Gouging-Form 52-529."



Las siguientes publicaciones, disponibles através de la American Welding Society, 550 N.W. LeJuene Road, Miami, FL 33126, son recomendadas para usted:

1. ANSI/ASC Z49.1 - "Safety in Welding and Cutting"
2. AWS C5.1 - "Recommended Practices for Plasma Arc Welding"
3. AWS C5.2 - "Recommended Practices for Plasma Arc Cutting"
4. AWS C5.3 - "Recommended Practices for Air Carbon Arc Gouging and Cutting"
5. AWS C5.5 - "Recommended Practices for Gas Tungsten Arc Welding"
6. AWS C5.6 - "Recommended Practices for Gas Metal Arc Welding"
7. AWS SP - "Safe Practices" - Reprint, Welding Handbook.
8. ANSI/AWS F4.1, "Recommended Safe Practices for Welding and Cutting of Containers That Have Held Hazardous Substances."



**SIGNIFICADO DE LOS SIMBOLOS** - Según usted avanza en la lectura de este folleto: Los Símbolos Significan ¡Atención! ¡Esté Alerta! Se trata de su seguridad.

Significa riesgo inmediato que, de no ser evadido, puede resultar inmediatamente en serio daño personal o la muerte.

**PELIGRO**

**ADVERTENCIA**

Significa el riesgo de un peligro potencial que puede resultar en serio daño personal o la muerte.

**CUIDADO**

Significa el posible riesgo que puede resultar en menores daños a la persona.



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## PRÉCAUTIONS DE SÉCURITÉ

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**AVERTISSEMENT:** Ces règles de sécurité ont pour objet d'assurer votre protection. Veuillez à lire et à observer les précautions énoncées ci-dessous avant de monter l'équipement ou de commencer à l'utiliser. Tout défaut d'observation de ces précautions risque d'entraîner des blessures graves ou mortelles.

**1. PROTECTION INDIVIDUELLE--** Les brûlures de la peau et des yeux dues au rayonnement de l'arc électrique ou du métal incandescent, lors du soudage au plasma ou à l'électrode ou lors du gougeage à l'arc, peuvent s'avérer plus graves que celles résultant d'une exposition prolongée au soleil. Aussi convient-il d'observer les précautions suivantes:

a. Portez un écran facial adéquat muni des plaques protectrices et des verres filtrants appropriés afin de vous protéger les yeux, le visage, le cou et les oreilles des étincelles et du rayonnement de l'arc électrique lorsque vous effectuez des soudures ou des coupes ou lorsque vous en observez l'exécution.

AVERTISSEZ les personnes se trouvant à proximité de façon à ce qu'elles ne regardent pas l'arc et à ce qu'elles ne s'exposent pas à son rayonnement, ni à celui du métal incandescent.

b. Portez des gants ignifugés à crispins, une tunique épaisse à manches longues, des pantalons sans rebord, des chaussures à embout d'acier et un casque de soudage ou une calotte de protection, afin d'éviter d'exposer la peau au rayonnement de l'arc électrique ou du métal incandescent. Il est également souhaitable d'utiliser un tablier ininflammable de façon à se protéger des étincelles et du rayonnement thermique.

c. Les étincelles ou les projections de métal incandescent risquent de se loger dans des manches retroussées, des bords relevés de pantalons ou dans des poches. Aussi convient-il de garder boutonnés le col et les manches et de porter des vêtements sans poches à l'avant.

d. Protégez des étincelles et du rayonnement de l'arc électrique les autres personnes travaillant à proximité à l'aide d'un écran ininflammable adéquat.

e. Ne jamais omettre de porter des lunettes de sécurité lorsque vous vous trouvez dans un secteur où l'on effectue des opérations de soudage ou de coupage à l'arc. Utilisez des lunettes de sécurité à écrans ou verres latéraux pour piquer ou meuler le laitier. Les piquetures incandescentes de laitier peuvent être projetées à des distances considérables. Les personnes se trouvant à proximité doivent également porter des lunettes de protection.

f. Le gougeage à l'arc et le soudage à l'arc au plasma produisent un niveau de bruit extrêmement élevé (de 100 à 114 dB) et exigent par conséquent l'emploi de dispositifs appropriés de protection auditive.

**2 PRÉVENTION DES INCENDES--** Les projections de laitier incandescent ou d'étincelles peuvent provoquer de graves incendies au contact de

matériaux combustibles solides, liquides ou gazeux.

Aussi faut-il observer les précautions suivantes:

a. Éloigner suffisamment tous les matériaux combustibles du secteur où l'on exécute des soudures ou des coupes à l'arc, à moins de les recouvrir complètement d'une bâche non-inflammable. Ce type de matériaux comprend notamment le bois, les vêtements, la sciure, l'essence, le kérosène, les peintures, les solvants, le gaz naturel, l'acétylène, le propane et autres substances combustibles semblables.

b. Les étincelles ou les projections de métal incandescent peuvent tomber dans des fissures du plancher ou dans des ouvertures des murs et y déclencher une ignition lente cachée. Veiller à protéger ces ouvertures des étincelles et des projections de métal.

c. N'exécutez pas de soudures, de coupes, d'opérations de gougeage ou autres travaux à chaud à la surface de barils, bidons, réservoirs ou autres contenants usagés, avant de les avoir nettoyés de toute trace de substance susceptible de produire des vapeurs inflammables ou toxiques.

d. En vue d'assurer la prévention des incendies, il convient de disposer d'un matériel d'extinction prêt à servir immédiatement, tel qu'un tuyau d'arrosage, un seau à eau, un seau de sable ou un extincteur portatif.

e. Une fois le travail à l'arc terminé, inspectez le secteur de façon à vous assurer qu'aucune étincelle ou projection de métal incandescent ne risque de provoquer ultérieurement un feu.

**3. CHOC ÉLECTRIQUE--** Le gougeage à l'arc et à l'arc au plasma exige l'emploi de tensions à vide relativement importantes; or, celles-ci risquent de causer des dommages corporels graves et même mortels en cas d'utilisation inadéquate. La gravité du choc électrique reçu dépend du chemin suivi par le courant à travers le corps humain et de son intensité.

a. Ne laissez jamais de surfaces métalliques sous tension venir au contact direct de la peau ou de vêtements humides. Veuillez à porter des gants bien secs.

b. Si vous devez effectuer un travail sur une surface métallique ou dans un secteur humide, veuillez à assurer votre isolation corporelle en portant des gants secs et des chaussures à semelles de caoutchouc et en vous tenant sur une planche ou une plate-forme sèche.

c. Mettez toujours à la terre le poste de soudage/coupage en le reliant par un câble à une bonne prise de terre.

d. N'utilisez jamais de câbles usés ou endommagés. Ne surchargez jamais le câble. Utilisez toujours un équipement correctement entretenu.

e. Mettez l'équipement hors tension lorsqu'il n'est pas en service. une mise à la masse accidentelle peut en effet provoquer une surchauffe de l'équipement et un danger d'incendie. Ne pas enrouler ou passer le câble autour d'une partie quelconque du corps.

f. Vérifiez si le câble de masse est bien relié à la pièce en un point aussi proche que possible de la zone de travail. Le branchement des câbles de masse à l'ossature du bâtiment ou en un point éloigné de la zone de travail augmente en effet le risque de passage

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## PRÉCAUTIONS DE SÉCURITÉ

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- g. Empêchez l'apparition de toute humidité, notamment sur vos vêtements, à la surface de l'emplacement de travail, des câbles, du porte-électrode et du poste de soudage/coupage. Réparez immédiatement toute fuite d'eau.
4. VENTILATION-- La respiration prolongée des fumées résultant des opérations de soudage/coupage, à l'intérieur, d'un local clos, peut provoquer des malaises et des dommages corporels. Aussi convient-il d'observer les précautions suivantes:
- a. Assurez en permanence une aération adéquate de l'emplacement de travail en maintenant une ventilation naturelle ou à l'aide de moyens mécaniques. N'effectuez jamais de travaux de soudage ou de coupage sur des matériaux de zinc, de plomb, de beryllium ou de cadmium en l'absence de moyens mécaniques de ventilation capables d'empêcher l'inhalation des fumées dégagées par ces matériaux.
  - b. N'effectuez jamais de travaux de soudage ou de coupage à proximité de vapeurs d'hydrocarbure chloré résultant d'opérations voisines de dégraissage ou de pulvérisation. La chaleur dégagée ou le rayonnement de l'arc peut déclencher la formation de phosgène -- gaz particulièrement toxique -- et d'autres gaz irritants, à partir des vapeurs de solvant.
  - c. Une irritation momentanée des yeux, du nez ou de la gorge constatée au cours de l'utilisation de l'équipement dénote un défaut de ventilation. Arrêtez-vous de travailler afin de prendre les mesures nécessaires à l'amélioration de la ventilation. Ne poursuivez pas l'opération entreprise si le malaise persiste.
  - d. Certaines commandes comportent des canalisations où circule de l'hydrogène. L'armoire de commande est munie d'un ventilateur destiné à empêcher la formation de poches d'hydrogène, lesquelles présentent un danger d'explosion; ce ventilateur ne fonctionne que si l'interrupteur correspondant du panneau avant se trouve placé en position ON (Marche). Veillez à manœuvrer cette commande en vérifiant si le couvercle est bien en place, de façon à assurer l'efficacité de la ventilation ainsi réalisée. Ne jamais débrancher le ventilateur.
  - e. Les fumées produites par l'opération de soudage ou de coupage peuvent s'avérer toxiques. Aussi est-il nécessaire de disposer en permanence d'un dispositif adéquat de ventilation de type aspirant, afin d'éliminer du voisinage de l'opérateur tout dégagement de fumée visible.
  - f. Consultez les recommandations particulières en matière de ventilation indiquées à l'alinéa 6 de la norme Z49.1 de l'AWS.
5. ENTRETIEN DE L'ÉQUIPEMENT-- Un équipement entretenu de façon défectueuse ou inadéquate risque non seulement de réaliser un travail de mauvaise qualité mais, chose plus grave encore, d'entraîner des dommages corporels graves, voire mortels en déclenchant des incendies ou des chocs électriques. Observez par conséquent les précautions suivantes:
- a. Efforcez-vous de toujours confier à un personnel qualifié l'installation, le dépannage et l'entretien du poste de soudage et de coupage. N'effectuez aucune réparation électrique sur l'équipement à moins d'être qualifié à cet effet.
  - b. Ne procédez jamais à une tâche d'entretien quelconque à l'intérieur du poste de soudage/coupage, avant d'avoir débranché l'alimentation électrique.
  - c. Maintenez en bon état de fonctionnement les câbles, le câble de masse, les branchements, le cordon d'alimentation et le poste de soudage/coupage. N'utilisez jamais le poste ou l'équipement s'il présente une défectuosité quelconque.
  - d. Prenez soin du poste de soudage et de coupage et des équipements accessoires. Gardez-les à l'écart des sources de chaleur, notamment des fours, de l'humidité, des flaques d'eau maintenez-les à l'abri des traces d'huile ou de graisse, des atmosphères corrosives et des intempéries.
  - e. Laissez en place tous les dispositifs de sécurité et tous les panneaux de l'armoire de commande en veillant à les garder en bon état.
  - f. Utilisez le poste de soudage/coupage conformément à son usage prévu et n'effectuez aucune modification.
6. INFORMATIONS COMPLÉMENTAIRES RELATIVES À LA SÉCURITÉ--
- Pour obtenir des informations complémentaires sur les règles de sécurité à observer pour le montage et l'utilisation d'équipements de soudage et de coupage électriques et sur les méthodes de travail recommandées, demandez un exemplaire du livret N° 52529 "Precautions and Safe Practices for Arc Welding, Cutting and Gouging" publié par ESAB. Nous conseillons également de consulter les publications suivantes, tenues à votre disposition par l'American Welding Society, 550 N.W. LeJuene Road, Miami, FL 32126:
- a. "Safety in Welding and Cutting" AWS Z49.1
  - b. "Recommended Safe Practices for Gas-Shielded Arc Welding" AWS A6. 1.
  - c. "Safe Practices for Welding and Cutting Containers That Have Held Combustibles" AWS-A6.0.
  - d. "Recommended Safe Practices for Plasma Arc Cutting" AWS-A6. 3.
  - e. "Recommended Safe Practices for Plasma Arc Welding" AWS-C5. 1.
  - f. "Recommended Safe Practices for Air Carbon Arc Gouging and Cutting" AWS-C5. 3.

## **1.1 INTRODUCTION**

The Heliarc 252 and Heliarc 352 AC/DC welding power sources are constant current AC/DC welding power sources for high quality tig and stick welding in both the AC and DC mode. The unique characteristics of the magnetic and solid state circuits provide excellent arc conditions for all tig welding as well as high alloy stick electrodes. The non-saturating current limiting reactor and electronic feedback control prohibits high current surges inherent with saturable reactors or solid state SCR control alone, therefore reducing spatter on stick electrodes as well as tungsten spitting when tig welding. The electronic firing circuit utilizes a voltage compensating circuit which compensates for line voltage variations of +/-10 percent.

Through its unique design, the Heliarc 252 and Heliarc 352 AC/DC combines all of the latest state-of-the art magnetic and solid state concepts to provide the wide range volt-ampere curve characteristics needed for a constant current AC/DC power source - see Figure 1-1 or 1-2. Refer to Table 1-1 for technical specifications.

## **1.2 DUTY CYCLE**

Duty cycle is defined as the ratio of load time to the total time. Standard current ratings are based on a 10-minute cycle. This machine is rated at 40 percent duty cycle which means the rated load is applied for a total of 4 minutes and shut off for a total of 6 minutes in a 10-minute period. However, if the welding current is decreased, the duty cycle can be increased. Conversely, if the welding current is increased, the duty cycle must be decreased. Figure 1-3 or 1-4 enables the operator to determine the safe output of the power source at various duty cycles. Note that the duty cycle of the unit is approximately 50% less when Balance Control is in the "max. penetration" position

Table 1-1. Specifications

		Heliarc 252 AC/DC					Heliarc 352 AC/DC				
Rated Output* @ 40% Duty Cycle		250 Amps @ 30 Volts AC/DC, Tig/Stick					350 Amps @ 34 Volts AC/DC, Tig/Stick				
Max. Open Circuit Voltage		79 Volts AC/72 Volts DC					79 Volts AC/72 Volts DC				
Output Current Range in Amperes	Welding Current	AC/DC, 5 to 320 Amps					AC/DC, 3 to 380 Amps				
Input Voltage AC		230 (208)/460 V, 1 ph, 60 Hz 230/460/575 V, 1 ph, 60 Hz 220/400 (380/415), 1 ph, 50 Hz					230 (208)/460 V, 1 ph, 60 Hz 230/460/575 V, 1 ph, 60 Hz 220/400 (380/415), 1 ph, 50 Hz				
Input Current @ Rated Load in Amperes***		220 V	230 V	400 V	460 V	575V	220 V	230V	400 V	460 V	575 V
	w/o P.F.C.**	100	96	52	48	38	160	152	84	76	61
	with P.F.C.**	88	70	39	35	29	145	110	64	55	43
Power Factor @ Rated Load	w/o P.F.C.**	Approx. 55%					Approx. 55%				
	with P.F.C.**	Approx. 76% (65% on 220 V)					Approx. 76% (65% on 220 V)				
Auxiliary Power Output		115 V AC, 10 Amp, 60 Hz					115 V AC, 10 Amp, 60 Hz				
Dimensions:	Width Depth Height	18.8 in. (463 mm) 32.5 in. (826 mm) 25 in. (635 mm)					18.8 in. (463 mm) 32.5 in. (826 mm) 25 in. (635 mm)				
Weight, Net****		375 lbs. (170 kg)					432 lbs. (196 kg)				
Weight, Shipping****		385 lbs. (175 kg)					442 lbs. (201 kg)				

\* For 208 Vac, 60 Hz or 380 Vac, 50 Hz, derate output current by 10%.

\*\* P.F.C. indicates with or without optional power factor correction kit.

\*\*\* The input currents listed are for balance control in the "max. clean" (0) position.

When balance control is set in the "max. penetration" (10) position, input current will increase approximately 40%.

\*\*\*\* For 50 Hz models, add 40 lbs (18 kg).

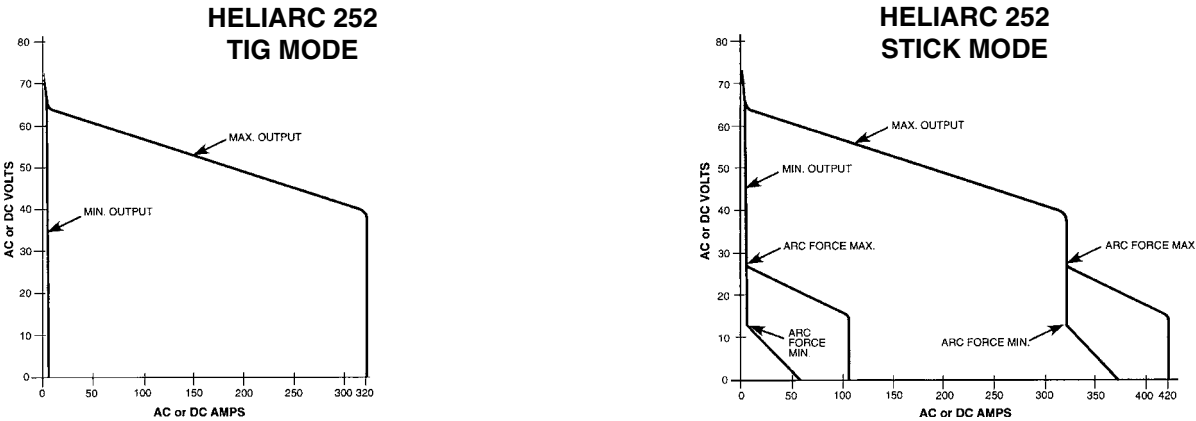


Figure 1-1 - Volt-Amp Curves, Heliarc 252 ac/dc

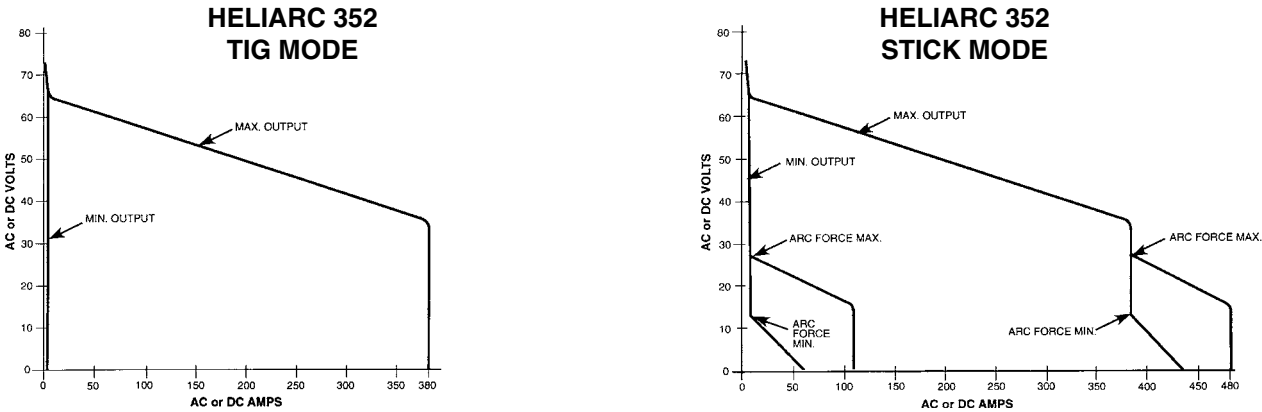


Figure 1-2 - Volt-Amp Curves, Heliarc 352 ac/dc

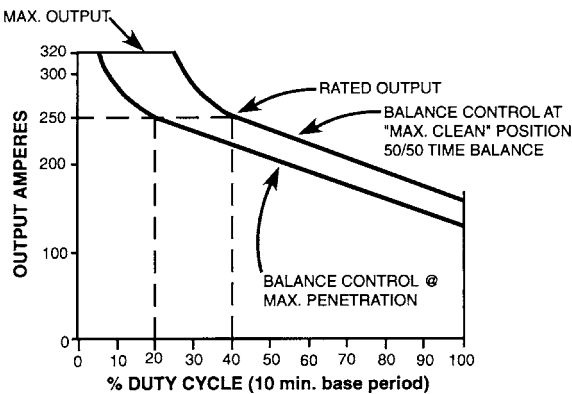


Figure 1-3 - Duty Cycle Chart, Heliarc 252 ac/dc

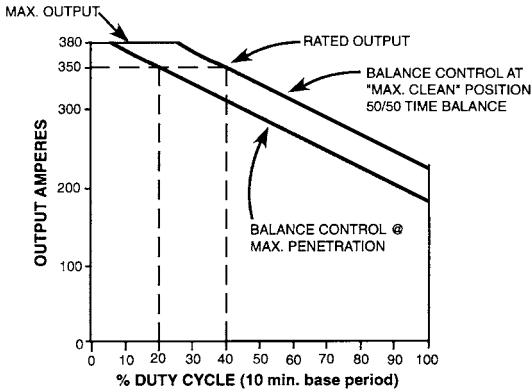


Figure 1-4 - Duty Cycle Chart, Heliarc 352 ac/dc

SECTION 1	DESCRIPTION
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## 2.1 GENERAL

Proper installation can contribute materially to the satisfactory and trouble-free operation of the power source. It is suggested that each step in this section be studied carefully and followed as closely as possible.

### 2.1.1 Unpacking and Placement

1. Immediately upon receipt of the power source, it should be inspected for damage which may have occurred in transit. Notify the carrier of any defects or damage at once.
2. After removing the power source from the shipping container, check the container for any loose parts. Remove all packing materials.
3. Check air passages at front, bottom, and rear of cabinet for any packing materials that may obstruct air flow through the power source.
4. If the machine is not to be installed immediately, store it in a clean, dry, well-ventilated area.
5. The location of the power source should be carefully selected to ensure satisfactory and dependable service. Using the lifting eyebolt, or a fork-lift truck, place the power source in the desired location. Choose a location relatively close to a properly fused supply of electrical power.
6. The power source's components are maintained at proper operating temperature by forced air which is drawn through the cabinet by the fan unit on the rear panel. The power source is designed to operate up to a 40 °C (104 °F) ambient temperature. For this reason, locate the machine in an open area where air can circulate freely at front, bottom, and rear openings. Leave at least 2 feet of clearance between the rear of the power source and wall or other obstruction.

**IMPORTANT:** *Do not use filters on this unit. Output ratings are designed and based on an unobstructed supply of "clean" cooling air drawn over its internal components. If cooling air is dirty (e.g., laden with conductive dust), the interior should be cleaned using low pressure air (see Maintenance).*

**WARNING**

**ELECTRIC SHOCK CAN KILL!** Before making electrical input connections to the power source, "Machinery Lockout Procedures" should be employed. If the connections are to be made from a line disconnect switch, place the switch in the off position and padlock it to prevent inadvertent tripping. If the connection is made from a fuse box, remove the corresponding fuses and padlock the box cover. If it is not possible to use padlocks, attach a red tag to the line disconnect switch (or fuse box) warning others that the circuit is being worked on.

## 2.2 PRIMARY (INPUT) ELECTRICAL CONNECTION

This power source is a single-phase unit and must be connected to a single-phase power supply. It is recommended that the unit be operated on a dedicated circuit to prevent impairment of performance due to an overloaded circuit.

1. The primary power leads must be insulated copper conductors. Two power leads and one ground wire are required. Either rubber covered cable or conduit (flexible or solid) may be used. Table 2-1 provides recommended input conductors and line fuse sizes.
2. Remove the top cover. Identify primary power input connections on the power switch, chassis ground lug on the "A" frame, and primary input terminal board. Refer to Figures 2-1 and 2-2.

**Table 2-1. Recommended Sizes for Input Conductors and Line Fuses**

Input Requirements		Input & Gnd. Conductor* CU/AWG	Time-Delay Fuse Size Amps.
Volts	Amps.		
230	100	No.6**	150
400	57	No.6	70
460	50	No.6	70
575	40	No.8	60
230***	130	No.4**	200

\* Sized per National Electric Code for 75°C rated conductors @ 30°C ambient. Not more than three conductors in raceway or cable. Local codes should be followed if they specify sizes other than those listed above.

\*\* Wire per National Electric Code Table 310-16 using 90°C rated conductors (e.g. THW-2, THWN, THHN).

\*\*\* Heliarc 352 only.

**WARNING**

The chassis must be connected to an approved electrical ground. Failure to do so may result in severe electrical shock, causing severe burns or death.

3. When using the provided strain relief, refer to Figure 2-1 for proper cable strip lengths. It is important to follow the cable strip guide to ensure that if the primary input cable is ever pulled from the strain relief, the input conductors will be pulled from the ON/OFF power switch before the ground lead is pulled from the ground lug. Once stripped, thread the input and ground conductors through the large strain-relief in the rear panel of the power source. Connect the ground wire to the terminal lug located on the right rear A-frame leg inside the power source. Connect the primary power leads to terminals L1 and L3 on the input power switch. Secure the strain relief on the input cable.
4. Check all connections for proper tightness. Ensure all connections are correct and well-insulated.



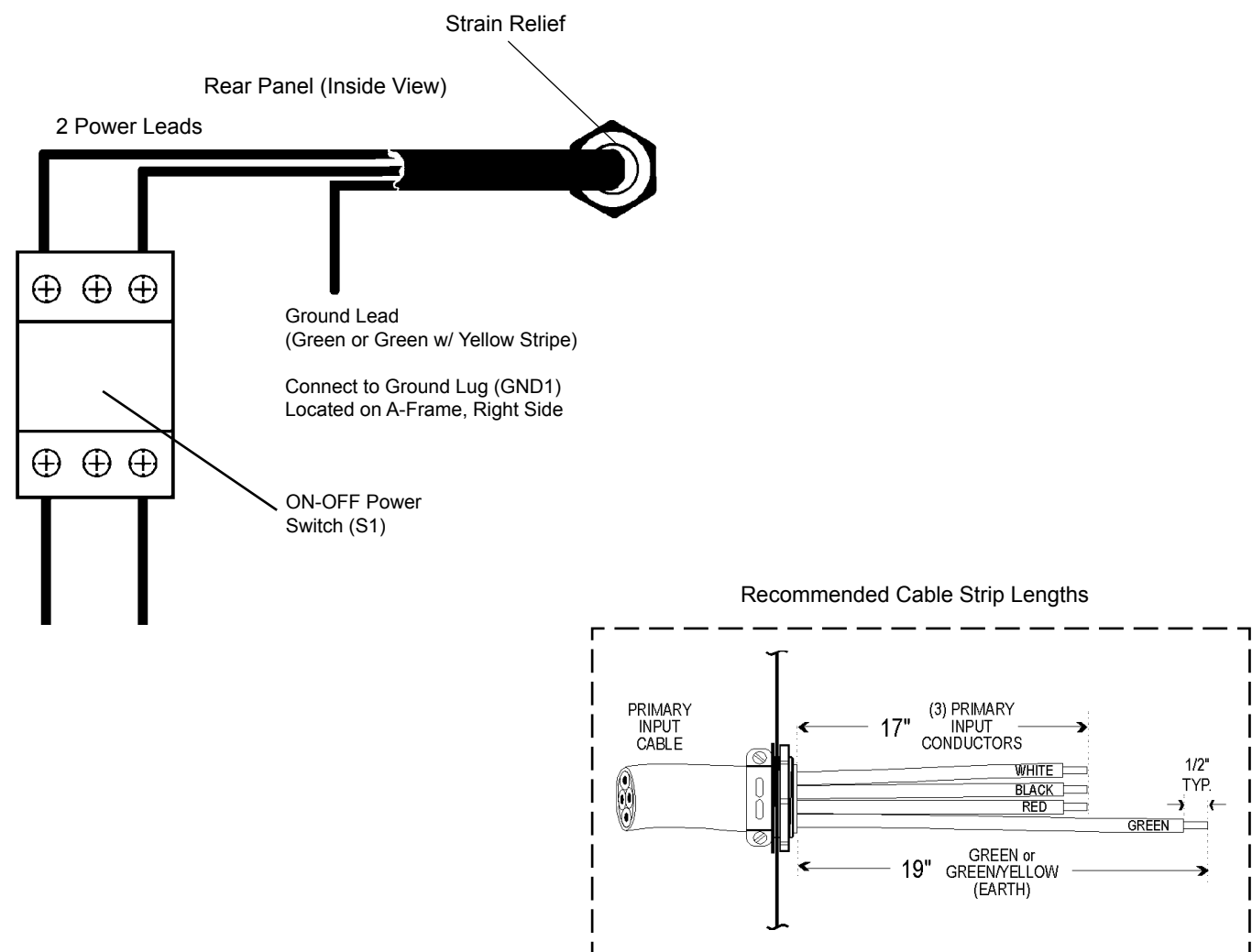


Figure 2-1. Connecting Primary Power Leads

5. Figures 2-2 thru 2-5 illustrate the input voltage terminal board and the input voltage link connections. The particular voltages from which this power source may be operated are stated on the rating plate. The voltage links were factory set for highest voltage stated on the rating plate. If the power source is to

be operated on another stated input voltage, the links must be reset for that particular input voltage. Always verify the input voltage and check the link arrangement regardless of factory setting. The voltage links are set up by reconfiguring the copper link bars to the voltage designations for the desired voltage.

### For 230 / 460 / 575V Models

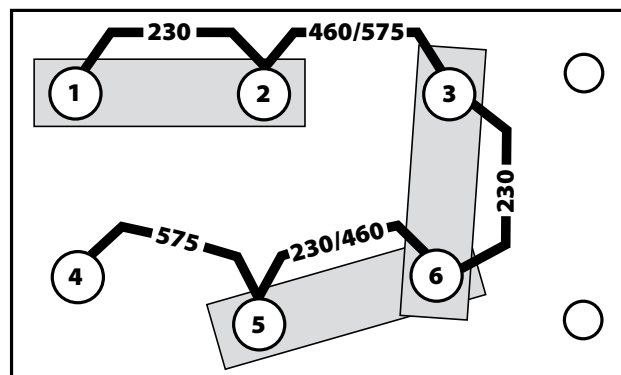


Figure 2-2. Input Terminal Board Configuration for 230V Input

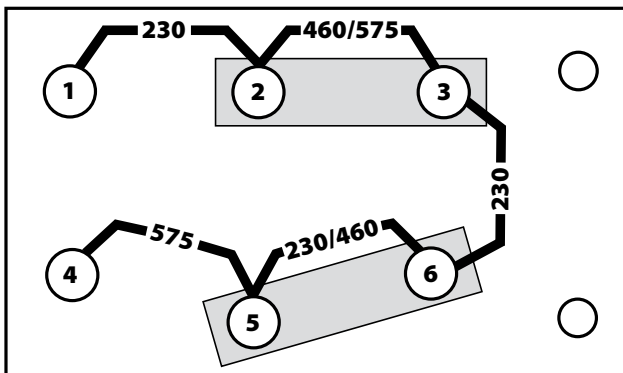


Figure 2-3. Input Terminal Board Configuration for 460V Input

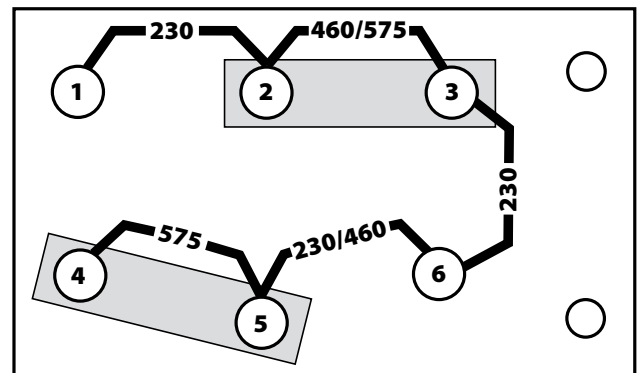


Figure 2-4. Input Terminal Board Configuration for 575V Input

For 220 / 400V Models

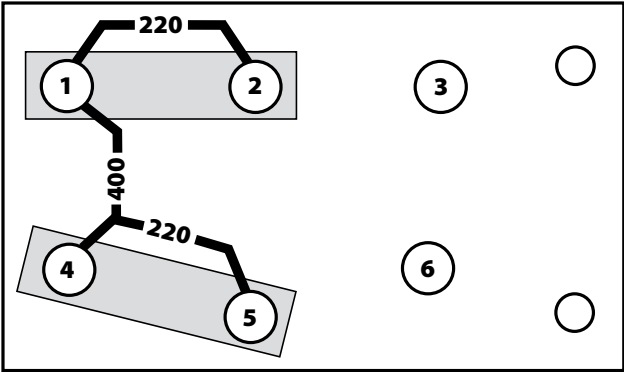


Figure 2-5. Input Terminal Board Configuration for 220V Input

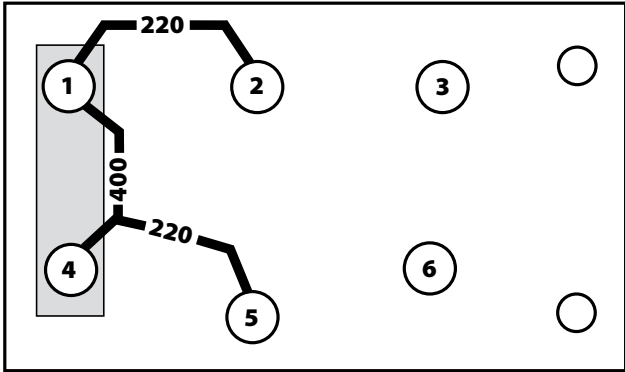


Figure 2-6. Input Terminal Board Configuration for 400V Input

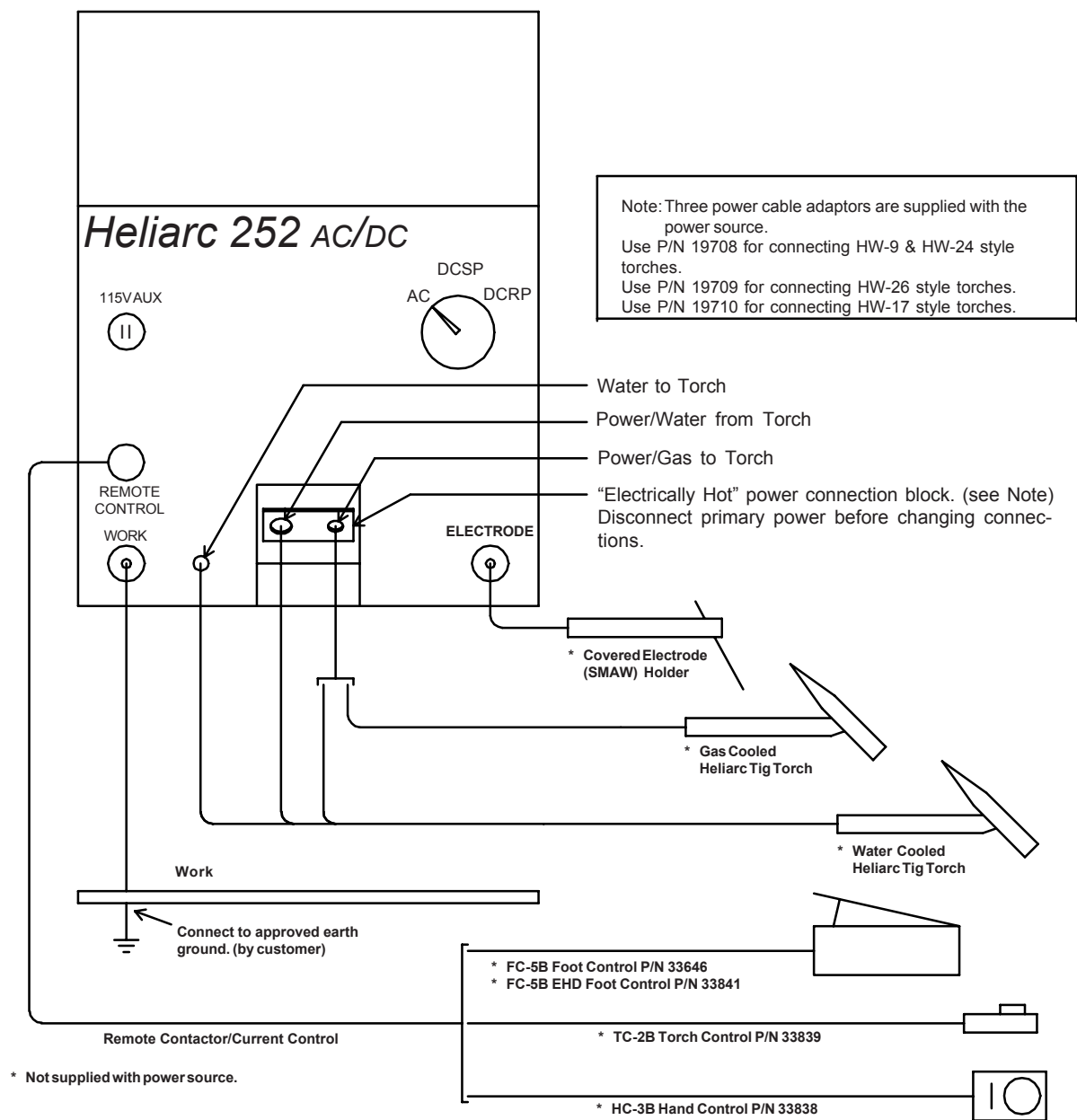


Figure 2-7 - Heliarc 252/352 Interconnection Diagram

**CAUTION**

Verify that all electrical connections comply with local electrical codes and especially with requirements established in booklet F-11-831 "High Frequency Stabilized Arc Welding Equipment", which is packed with this power source.

**WARNING**

Before making any connections to the power source's output receptacles, make sure that all primary input power to the machine is deenergized (off) at the customer's disconnect switch.

## 2.3 SECONDARY (OUTPUT) CONNECTIONS

Refer to Interconnection Diagram, Figure 2-5, for typical secondary output, process gas and water, and torch connections that are required for this unit's welding application.

The proper operation of the welding machine depends to a great extent on the use of output cables that are insulated copper, adequately sized, in good condition, and properly connected to the machine using UL listed pressure wire connectors. **It is recommended that the output cables be kept as short as possible (this is particularly important for tig applications using high frequency AC),** and have adequate current carrying capacity. The resistance of the output cables and connections causes a voltage drop which is added to the voltage of the arc. Excessive cable resistance may result in overloading as well as reducing the maximum current output of which the power source is capable. The welding output terminals are located on the front panel. Table 2-2 will prove useful for selecting the recommended output cable size.

**Table 2-2. Recommended Output Cable Sizes**

Welding Current, Amps	Total Length ( Feet) of Cable in Weld Circuit*				
	50	100	50	200	250
200	2	2	1	1	1/0
250	1	1	1/0	1/0	1/0
300	1/0	1/0	1/0	2/0	3/0
350	1/0	2/0	3/0	3/0	4/0

\*Total cable length includes work and electrode cables. Cable size is based on direct current, insulated copper conductors, 40% duty cycle, and a voltage drop of 4 or less volts. The welding cable insulation must have a voltage rating that is high enough to withstand the open circuit voltage of the machine.

## 2.4 ACCESSORIES

- 1. FC-5B Foot Current/Contactor Control, P/N 33646 or FC-5BEHD Foot Current/Contactor Control, P/N 33841.** This device provides the operator with remote control of current and contactor operation at the welding station. Interconnection of these functions to the main unit is provided by a mating 30-foot cable/plug assembly. By depressing the foot pedal, the weld-start sequence circuit will energize, and the welding current will increase or decrease within the range preset on the power source Current Control potentiometer.
- 2. TC-2B Torch Current and Contactor Control, P/N 33839 (30-ft lg).** This remote fingertip control is designed to be taped to any Tig torch handle and to provide the operator with complete contactor control and variable control of the welding current. By simply rotating the knob clockwise (off of zero), the integral switch will energize the contactor. Further rotation (clockwise) will increase the output current up to the limit preset on the power source main control.
- 3. HC-3B Current Hand Control, P/N 33838.** This accessory operates in series with the power sources "main current control" potentiometer to provide remote (up to 25-ft.) current regulation. The hand control potentiometer's current adjustment is always controlled by and limited to the range that is preset on the main current control.

4. **TR-23A Truck Kit, P/N 36224.** Provides complete mobility for power source. Includes handle, 4 castors and gas cylinder bracket.
5. **AC/DC Digital Meter Kit with Current Preset, P/N 36226 (Optional for Heliarc 252; installed in Heliarc 352).** This meter kit provides direct accurate reading of AC and DC open-circuit and welding voltages as well as welding current. The kit mounts directly to the front of the power source. A plugged hole in the front panel of the unit provides access for the meter. Allows pre-set of welding current.
6. **WC-8C Coolant Circulator, P/N 33739.** A self contained 1.5 gallon capacity water cooler suitable for most water cooled torch applications. The unit circulates 1 gallon per minute at 60 psi and operates from 115 volt, 60 Hz., 1 phase (5.4 amp) input. The circulator fits in place of cylinder in the TR-23 Truck.
7. **Current (Slope) Control Module, with Trigger Lock, P/N 36228.** Allows setting of start (initial) current, up-slope time, down-slope time, and final current, as well as standard or latching torch trigger.

**NOTE:** When using pulse and/or slope control, dip switch settings on main control board must be reset, see 4.1.6 in the Maintenance section.

8. **Pulse Control Kit, P/N 36227.** Allows independent setting of Peak Current (I1), Peak Time (T1), Background Current (I2), Background Time (T2). Has a three position switch for setting Peak (I1), Background (I2) and Pulse modes.
9. **Power Factor Kit, P/N 36220.** This kit when installed in power source will reduce input current draw at least 20%. It consists of 3 prewired power factor capacitors that installs easily inside the power source.

### 3.1 CONTROL FUNCTIONS (Refer to Fig. 3-1)

- A. **Power On-Off (I-O) Switch (S1).** Switch is located on the rear panel. In the OFF position, the power source is electrically shut down. In the ON position, Power On light on front control panel will light and power is being provided to all circuits in the power source.
- B. **CONTACTOR Switch (S3).** This 3-position toggle switch sets the operational modes which can be used. In the STICK position (with the toggle UP), the solid-state contactor circuits immediately energize, and welding power is continuously present at the output terminals. In the TIG REMOTE position (toggle at mid-position), the solid-state contactor and other tig sequencing circuits are controlled by a remote device (foot or torch switch) through the Remote Control receptacle. In TIG position (toggle down) the contactor is always on.
- C. **Current Control (Panel-Remote) Switch (S5).** This 2-position toggle switch determines the location from which welding current will be operated; PANEL position from the power source Weld Current potentiometer, or REMOTE position from an optional foot or hand control that plugs into the Remote Control receptacle. When the REMOTE position is selected, the optional remote control will vary the welding current, but only within the range preset on the power source Weld Current potentiometer (R3).
- D. **Remote Control Receptacle (J2).** This receptacle allows you to plug-in a remote accessory (i.e., foot or hand control) to provide remote current and/or contactor control, depending on the Panel/Remote selection of panel switches described in Items B and C above.
- E. **Current Selector Switch (S2).** A 3-position switch offers a choice of AC, DCSP, or DCRP output current to suit your particular welding applications. Placing the switch in its DCSP mode causes the output terminals to assume the following polarities; work is positive, and torch/electrode is negative. Conversely, when the switch is in DCRP; work is negative and torch/electrode is positive. **Do not change the position of this switch while welding or under load.**
- F. **Current Control (R3).** This control provides adjustment of welding current. The panel-faced dial provides an accurate reference for presetting and/or adjusting the control.
- G. **High Frequency Selector Switch (S4).** A 3-position toggle switch controls high frequency.

The functional positions are: **Off** -- no high frequency (this is the normal position for all stick welding or scratch start TIG), **Continuous** -- high frequency is provided throughout the entire welding cycle (this is the normal position for all AC Tig welding), and **Start** -- high frequency initiates immediately and cuts off when the arc is established (this last position is normal for most DC Tig welding applications).

- H. **Post Flow Control (R2).** This control provides a timed (from 3 to 30 seconds) post-flow of shielding gas after the welding arc is broken.

**NOTE:** The power source also has 0 to 5 seconds preflow capability which is factory set to zero seconds. If preflow is desired, locate R37 trim pot on the Control PC board assembly mounted behind the front control panel and then turn trim pot clockwise to desired position with a small screwdriver.

- I. **Auxiliary 115-Volt Receptacle.** This receptacle can be utilized to source 115-volt power for auxiliary equipment (grinder, coolant circulator, etc.) and is protected by a 10-amp circuit breaker.
- J. **Arc Force Control (R5).** This control is used in the STICK mode only. The lower settings provide less short circuit current and a softer, more stable arc. The higher settings provide more short circuit current and a forceful, more penetrating arc. For most Stick welding, set the knob at 3 or 4 and readjust up (forceful) or down (softer) as desired.
- K. **Balance Control (R4).** This control changes the wave balance for Tig welding operations (see Fig. 3-2). It is not operative in Stick welding operations. With the dial set in its extreme counterclockwise or "Max. Cleaning" position, the power source is set up for "balanced" wave operation (equal portions of reverse and straight polarity - 50/50) for use in DC and AC Tig with Maximum Cleaning (and minimum penetration). This will be the normal (counterclockwise) position for most applications. As the potentiometer is turned clockwise toward "Max. Penetration", cleaning action will lessen and penetration will increase. This "unbalanced" wave output (more straight than reverse polarity) should only be used for AC Tig applications when needed.
- L. **Volt/Amp Switch and Digital Meter (Optional on Heliarc 252).** With toggle switch in AMP position, digital meter will display preset current and then actual current after the arc has been struck. With toggle switch in VOLT switch, actual output voltage will always be displayed on the digital meter.
- M. **Over Temperature Light.** When this lights up, the power source has overheated (exceeded duty cycle). The contactor will deenergize shutting down all operations but the fan will continue to run. When the light goes off, operations can be resumed.
- N. **24V Circuit Breaker (CB1)**  
The 24V resettable circuit breaker (CB1) protects the solenoid valve and torch trigger circuitry against overcurrent. (Section 5-2 provides troubleshooting information)
- O. **115V Circuit Breaker (CB2)**  
The 115V resettable circuitry breaker (CB2) protects the 115 volt auxiliary receptacle circuitry against overcurrent. (Section 5-2 provides troubleshooting information).



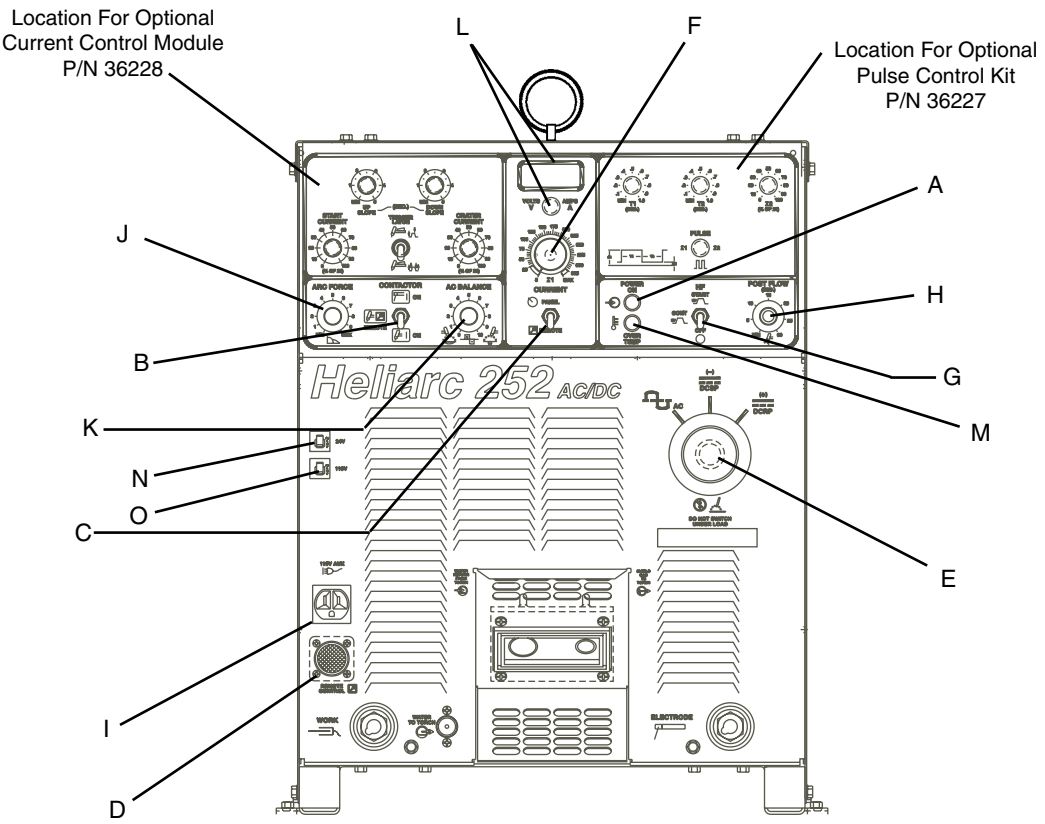
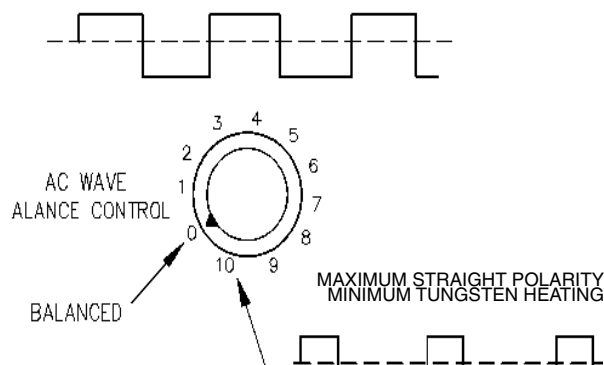


Fig. 3-1. Heliarc 252/352 Controls Locations



**Figure 3-2. Square Wave Operation**

**IMPORTANT:** When using "Maximum Penetration" in AC Tig; the duty cycle will be reduced 50% and input current will increase approximately 40%. Also, when DCTig welding, the Balance Control should always be set to the Maximum Cleaning (balanced wave) position.

**NOTE:** Square wave power sources generally offer better cleaning in AC tig welding than conventional saturable reactor machines. The extra cleaning results from more reverse polarity which decreases the maximum current for a given electrode. The following may help to resolve this situation: (1) Adjust the balance control for less cleaning, (2) use a larger electrode, and (3) use 2% thoriated tungsten.



**ELECTRIC SHOCK CAN KILL!** Do not use AC output in damp areas, if movement is confined, or if danger of falling exists.

Use AC output only if required for the welding process.



Never, under any circumstances, operate the power source without its panels in place. In addition to the safety hazard, improper cooling may cause overheating which will damage the internal components. Also, make sure you are adequately protected before you start welding -- welding helmet, gloves, and ear protection and safety glasses with side shields should always be worn.



**ELECTRIC SHOCK CAN KILL!** Do not use AC output in damp areas, if movement is confined, or if danger of falling exists.

Use AC output only if required for the welding process.



Do not change the position of this switch while welding.

## 3.2 SEQUENCE OF OPERATION

### 3.2.1 Stick Electrode / Shielded Metal Arc Welding

1. Connect all welding cables to workpiece and electrode holder as shown on the Interconnection Diagram, Fig. 2-3.
2. Place the power source's Power ON-OFF and High Frequency Selector switches to the OFF position.
3. Close the main (wall) disconnect switch or circuit breaker to provide input voltage to the power source.
4. Place the Current Selector switch to AC, DCSP, or DCRP depending on your welding application.
5. Leave the High Frequency Selector switch in its OFF position.
6. Adjust the Current Control potentiometer for the approximate desired welding current.
7. Set the Arc Force control at 3 or 4 on the dial and readjust as necessary to provide a softer or harder welding arc as described in Section 3.1-L
8. Place the Power ON-OFF switch to the ON position. Place the CONTACTOR toggle switch to the STICK (up) position. This will immediately energize the power source up to the output terminals and the electrode holder. Commence welding by touch or scratch starting.
9. If necessary, readjust the Current Control potentiometer and/or Arc Force control to obtain the exact welding condition required.

### 3.2.2 TIG Welding

1. Make the necessary welding power and service connections as shown on the Interconnection Diagram, Fig. 2-3.
2. Set the Power ON-OFF switch to the OFF position.
3. Set the CONTACTOR switch to the TIG or TIG REMOTE (down or middle) position. The REMOTE position requires that a torch switch or foot control be plugged into the Remote Control receptacle (J2) in order to make and break the welding sequence.
4. Close the main (wall) disconnect switch or circuit breaker to provide input voltage to the power source.
5. Place the Current Selector switch in AC, DCSP, or DCRP position. The AC position is primarily used for welding of aluminum and magnesium. The DCSP position will normally be used to cover all of the remaining metals (steel, copper, refractory, etc.) and alloys. The DCRP position produces a shallow weld, which makes it suitable for joining thin sheets of metal (e.g., magnesium, foil, etc.)

**WARNING**

**ELECTRIC SHOCK CAN KILL!** Do not use AC output in damp areas, if movement is confined, or if danger of falling exists.

Use AC output only if required for the welding process.

**CAUTION**

Do not change the position of this switch while welding.

6. Set the Balance control to the position which best suits your "AC-Tig" welding condition — Remember that when using "Maximum Penetration" mode, your duty cycle (AC welding arc time) must be reduced (see Fig. 1-3 or 1-4 - Duty Cycle chart). Also remember that for DC welding applications, this control should always be set for "Maximum Cleaning".
7. Adjust the Current Control potentiometer for the approximate welding current desired. Remember, that the setting placed on this potentiometer will be the maximum current which can be regulated from a Remote Foot or Torch Control.
8. Depending on the type of current regulation desired, place the "PANEL-REMOTE" Current Control switch (SW5) as follows:

**PANEL Position** -- permits full range current regulation only from the power source's Current Control potentiometer.

**REMOTE Position** -- permits current regulation from a remote location by connecting either the Foot or Torch control options to the Remote Control receptacle (J2). **Note that welding current regulation from the remote control option is "always" limited to the maximum current that you preset on the power source main Current Control dial.** For example: if the main Current Control dial is set at 50, the remote control will provide full range, finer tuned current values up to the equivalent setting of 50 on the main Current Control dial; however, if you want complete remote current control operation, the main Current Control dial on the power source **must** be set at the maximum.

9. Depending on your welding application, place the High Frequency Selector switch in the START or CONTINUOUS position.
10. Set the POSTFLOW control to provide the desired interval of post-flow shielding gas (from 3 to 30 seconds) after the welding arc voltage is broken.
11. Place the Power ON-OFF switch to the ON position. This will immediately energize the power source up to its solid state contactor.
12. To establish the welding arc, position the torch electrode near the workpiece (i.e., 1/8" typical) and close the Remote Torch or Foot Control. This will energize the solid state contactor and provide high frequency and welding current to initiate the arc.
13. If necessary, readjust the panel or remote Current Control until you secure the exact condition desired.



**WARNING**

Be sure that the wall disconnect switch or circuit breaker is open before attempting any inspection or work inside of the power source. Always wear safety goggles with side shields when blowing out the unit with low pressure air.

## 4.1 MAINTENANCE

If this Equipment does not operate properly, stop work immediately and investigate the cause of the malfunction. Maintenance work must be performed by an experienced person, and electrical work by a trained electrician. Do not permit untrained persons to inspect, clean, or repair this Equipment. Use only recommended replacement parts.

### 4.1.1 Cleaning

Since there are no moving parts (other than the fan) in the power source, maintenance consists mainly of keeping the interior of the cabinet clean. Periodically, remove the cover from the cabinet and blow accumulated dust and dirt from the air passages and the interior components, using clean low pressure air. It is imperative that the air passages, to the interior of the unit, be kept free of dirt accumulation to ensure adequate circulation of cooling air, especially over the rectifier bridge plates and PC boards. The length of time between cleaning will depend on the location of the unit and the amount of dust in the atmosphere.

### 4.1.2 Lubrication

Fan motors with oil tubes require lubrication after 1 year of service. Motors without oil tubes are permanently lubricated and do not require any attention.

### 4.1.3 Spark Gap Servicing

This component is part of the high frequency assembly. It will probably be necessary to readjust these gaps after extended operation, or if erratic high frequency operation is noted. It is important that the gaps be adjusted with a feeler gauge rather than by eye. Cleaning and dressing of spark gap points is not recommended since the points are tungsten and difficult to file. Points (P/N 673578) should be replaced as a set.

#### 4.1.4 Spark Gap Adjustment

Generally, the high frequency output of the unit increases as the gap setting is increased. Electronic instability in other equipment may occur if the gap is opened more than the factory-set .030 inches (+/- .002-in.). However, if the high frequency intensity is not sufficient for your application; open or close the spark gaps until the desired high frequency intensity is obtained. Remember that high frequency radiation increases as the gap increases, and this can cause interference in other electronic equipment.

1. Loosen retaining screw "A" only enough to free electrode point "C" for adjustment.
2. Place feeler gauge of proper thickness between gap "B".
3. Apply slight pressure against loosened electrode point "C" so the feeler gauge is held firmly in the gap. Tighten retaining screw "A".

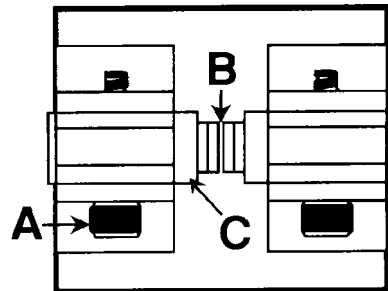


Figure 4-1. Spark Gap Adjustment

#### 4.1.5 Testing and Replacing Bridge Assy. Components

SCRs are devices which allow current to flow in only one direction and block current in the other direction. The SCRs used in this power source are designed to provide long trouble-free operation; however, should a failure occur, they may require replacement. The testing procedures to determine defective components are as follows:

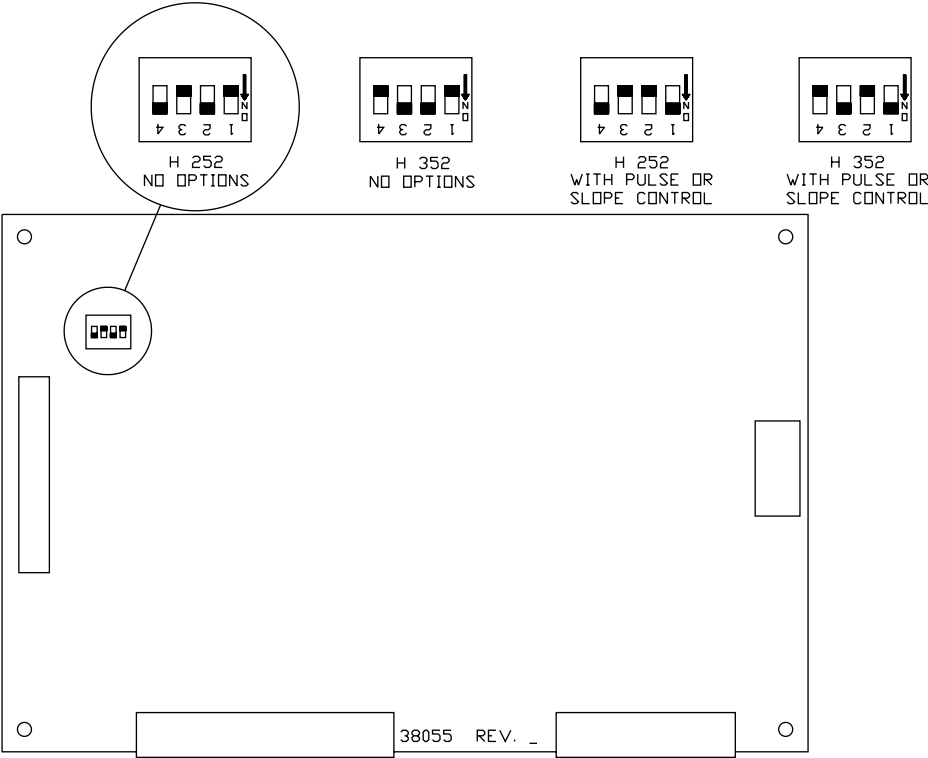
1. Silicon Controlled Rectifier - Modules.  
Disconnect the SCR wiring to break continuity and provide an open circuit across the component to be tested. Using an ohmmeter set to the R x 1 scale, check the resistance across the SCR in both directions. A good SCR will read high in both directions. If the reading is low or zero in either direction, the SCR is defective.

When replacing defective SCRs, make sure the mounting surfaces are clean. Make certain the polarity on the replacement SCR is the same as on the unit being replaced.



4.1.6 Dip Switch Setting of Main Control Board Assembly

Referring to the diagram below, the dip switches on the Main Control PC Board assembly (38055 or 38089) are factory positioned as shown with no options on the Heliarc 252 and 352 power sources. If a pulse and/or slope control option is installed, the dip switches must be repositioned as shown.





### 5.1 General



#### **WARNING**

Be sure that all primary power to the machine has been externally disconnected. Open wall disconnect switch or circuit breaker before attempting inspection or work inside of the power source.

If power source is operating improperly, the following troubleshooting information may be used to locate the source of the trouble.

Check the problem against the symptoms in the following troubleshooting guide (Table 5-1). The remedy may be quite simple. If the cause cannot be quickly located, open up the unit and perform a simple visual inspection of all the components and wiring. Check for secure terminal connections, loose or burned wiring or components, bulged or leaking capacitors, or any other sign of damage or discoloration.

Table 5-1. Troubleshooting Guide

CONDITION	ACTION
1-Unit completely Inoperative	<p>A. Open line fuses - check the line fuses for continuity and replace if necessary. If the fuses continue to open, the jumper links may not be in proper position. See Primary Electrical Connections.</p> <p>B. No power input - check position of line disconnect switch.</p> <p>C. Improper jumper link placement on input terminal board. See Primary Electrical Connection.</p> <p>D. Defective power on/off switch (S1) on rear panel - check continuity of S1 and replace if necessary.</p>
2-No welding output. Fan operative	<p>A. Power source magnetics overheating-thermal switch (TS1 or TS2) tripped due to restricted cooling air flow, or over extended duty cycle. Allow unit to cool for at least 5 minutes with fan running to let TS reset.</p> <p>B. Contactor switch (S3) in the TIG REMOTE (middle) position without a remote contactor control connected to the Remote Control receptacle J2. Place S3 in STICK (up) or TIG ON (down) position or make remote torch connection at J2.</p> <p>C. Defective Contactor switch (S3) and/or wiring. Check continuity and replace if necessary.</p> <p>D. Defective Control PC board.</p> <p>E. Defective Current Selector switch (S2) and/or wiring. Check continuity of S2 and ensure that all connections are secure and correct. Replace S2 if defective.</p> <p>F. Defective Current Control potentiometer (R3).</p>
3-Low or unstable open-circuit voltage	<p>A. Current control pot set too low for welding application. Increase setting of R3.</p> <p>B. Defective SCR in main bridge. Check the resistance across the SCR on the R x 1 scale. If the reading is high, the SCR is good. If the resistance is low or zero, the SCR is defective. To check the gate, connect the gate lead to the anode of the SCR and read the forward resistance across the SCR anode to cathode. If the internal voltage of the meter is high enough, the meter should read a low resistance.</p> <p>C. Defective Current Selector switch (S2) and/or wiring. See Condition 2 -E.</p> <p>D. Defective Control PC board.</p>
4-Erratic output weld current.	<p>A. Intermittent shunt connections. Check connections to shunt.</p> <p>B. Defective SCR in main bridge. See Condition 3-B.</p> <p>C. Defective Control PC board. Replace PC board.</p> <p>D. Excessive high frequency. Check spark gaps and adjust if necessary (see Maintenance Section). Check all connections and components in high frequency bypass circuit and replace any defective components.</p>
5-Minimum welding output.	<p>A. Check for defective Current Control potentiometer (R3).</p>
6-High weld output, current control does not vary the output.	<p>A. Open shunt connection. Check connections to shunt.</p> <p>B. Defective Control PC board. Replace if defective.</p>
7-Absence of High Frequency while selector switch (S4) is in START mode only.	<p>A. Control PC board may be defective. Replace if defective.</p>
8-Insufficient or absence of high frequency	<p>A. High frequency switch in the OFF position. Check S4 and place in START or CONTINUOUS position.</p> <p>B. Improper spark gap. Clean and adjust spark gaps, if necessary. See Spark Gap Servicing.</p> <p>C. Defective S4 and/or wiring. Make continuity check and replace if necessary.</p> <p>D. Defective Control PC board.</p>

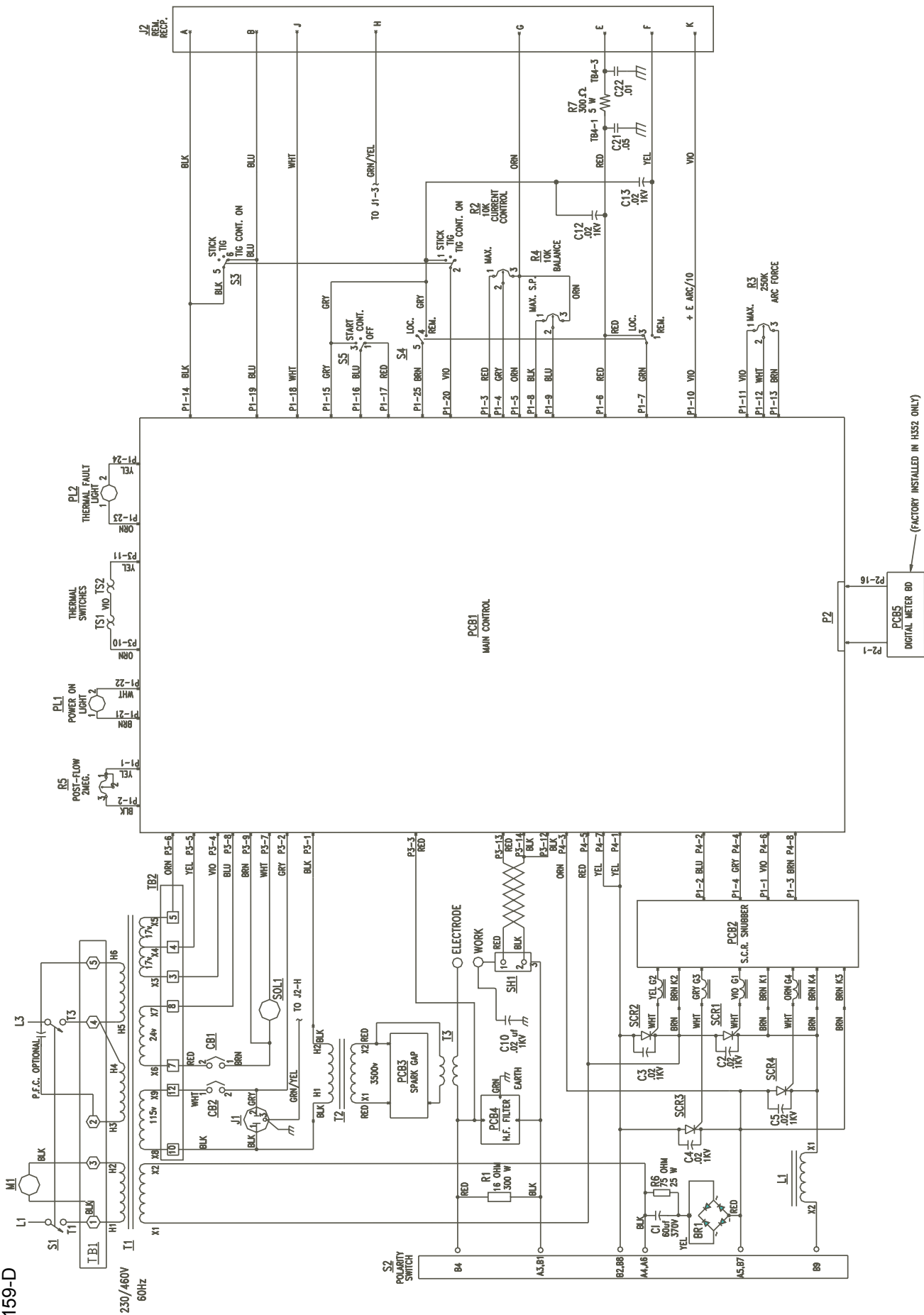


Figure 5-1. Schematic Diagram - Hellicar 252/352 AC/DC, 230/460 vac, 60 Hz, 1 ph.



Figure 5-2. Wiring Diagram - Heliarc 252/352 AC/DC, 230/460 vac, 60 Hz, 1 ph.

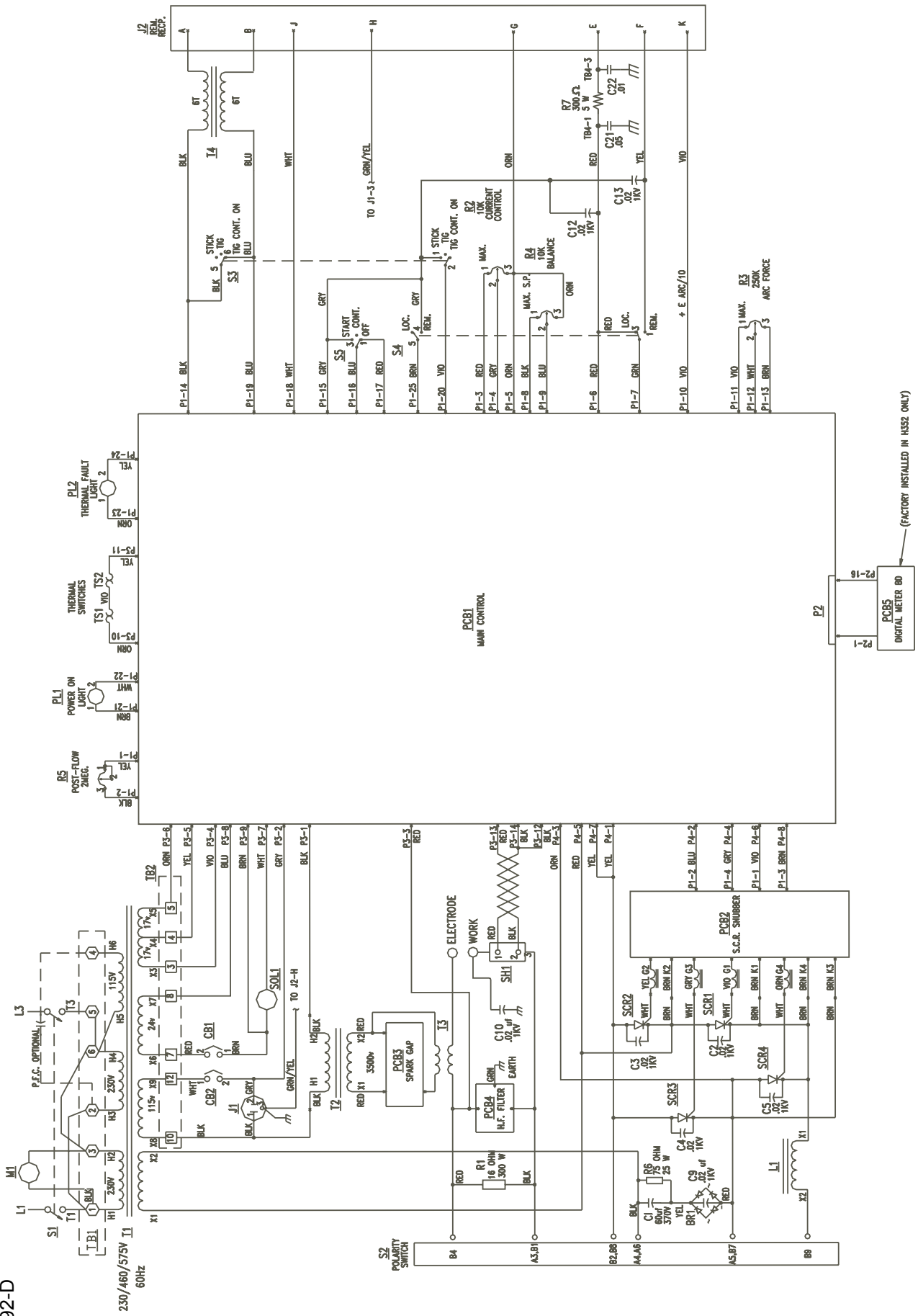
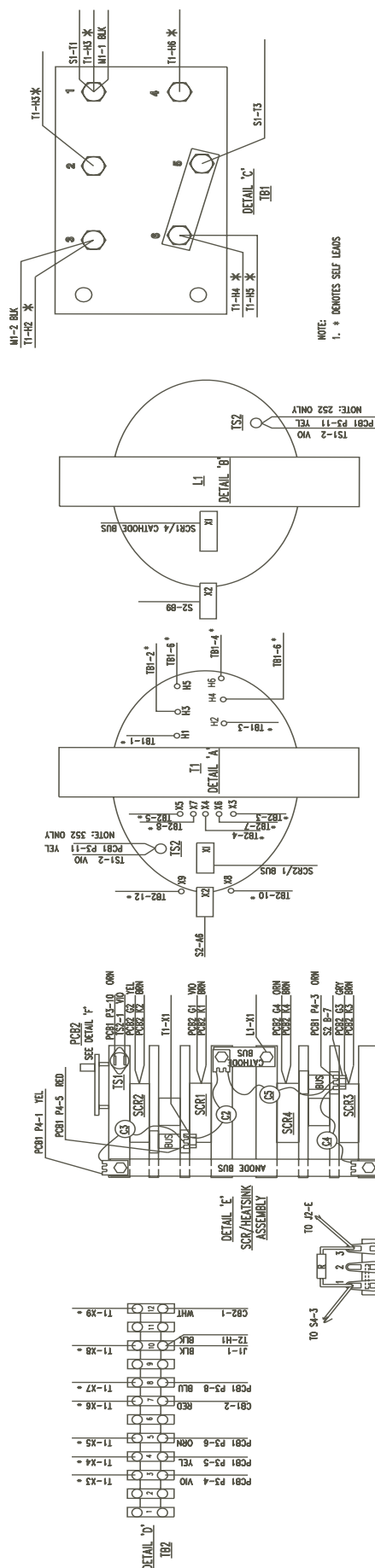
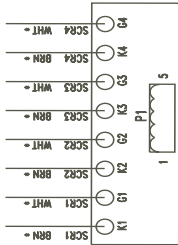
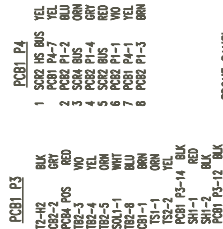


Figure 5-3. Schematic Diagram - Heliarc 252/352 AC/DC, 230/460/575 vac, 60 Hz, 1 ph.



184



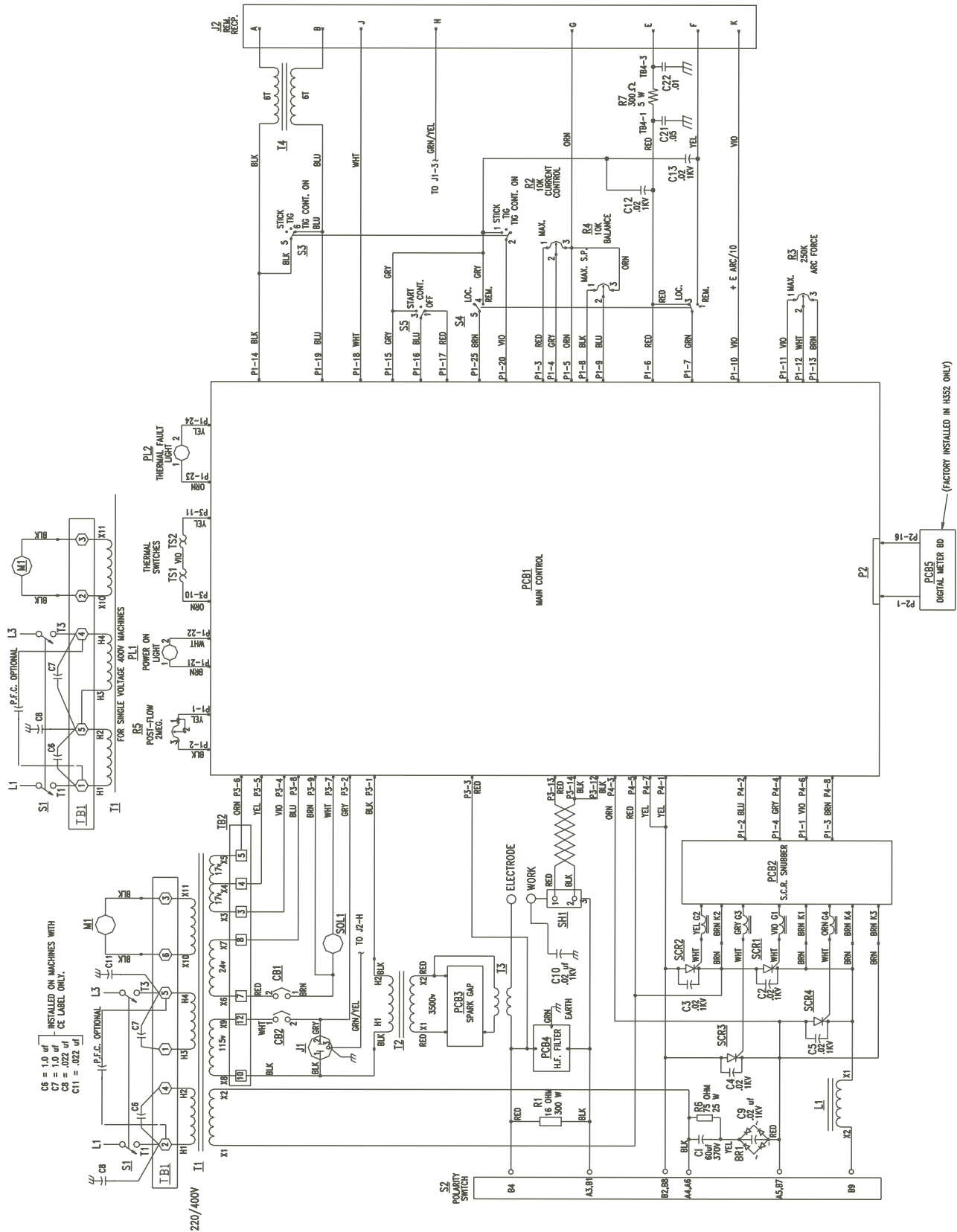


Figure 5-5. Schematic Diagram - Heliarc 252/352 AC/DC, 220/400 vac, 50 Hz, 1 ph.



## **6.1 GENERAL**

Always provide the series or serial number of the unit on which the parts will be used. The serial number is stamped on the unit nameplate.

## **6.2 ORDERING**

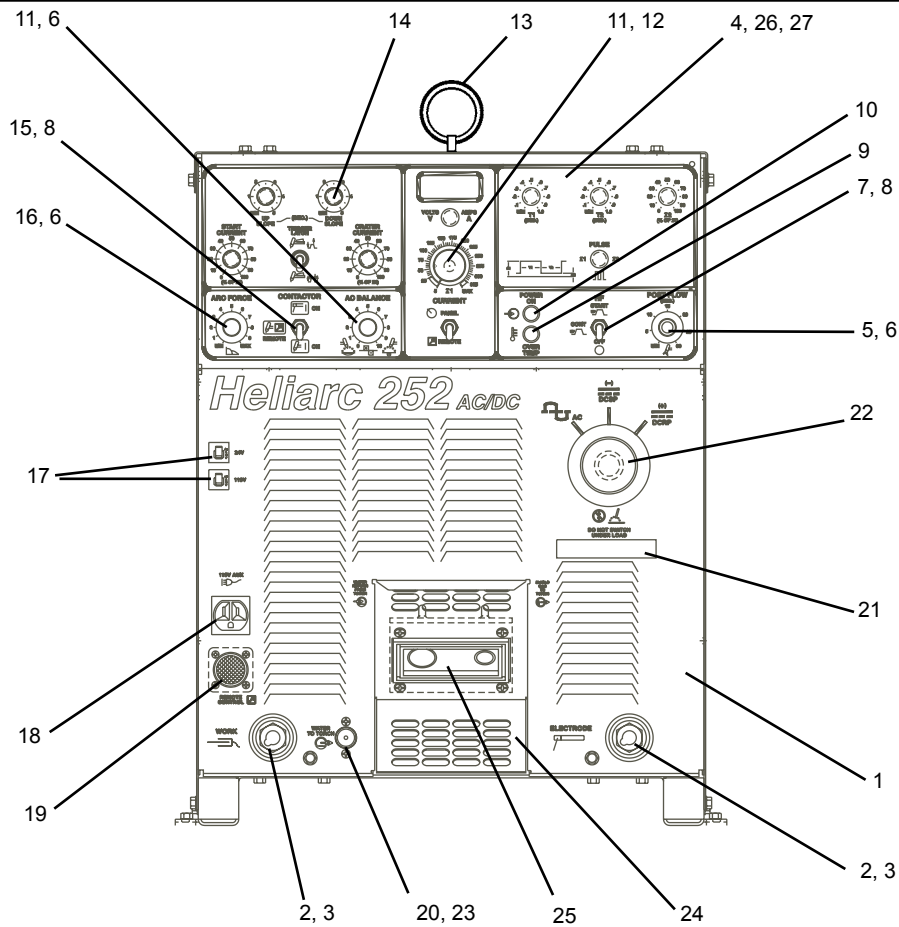
To assure proper operation, it is recommended that only genuine ESAB parts and products be used with this equipment. The use of non-ESAB parts may void your warranty.

Replacement parts may be ordered from your local distributor. Be sure to indicate any special shipping instructions when ordering replacement parts.

Refer to the Communication Guide located on the last page of this manual for a list of customer service phone numbers.

## SECTION 6

## REPLACEMENT PARTS



**FIG.6-1 Heliarc 252/352, Front View**

No.	Qty. Req.	Item No.	Circuit Description	Symbol
1	1	36067M	Panel, Front Screened (H 252)	OTB
	1	36189M	Panel, Front Screened (H 352)	
2	2	13733935	Receptacle, Cable 2-1/0	
3	2	13733936	Connector, Quick (Not Shown)	
4	1	36068M	Panel Control	
5	1	951511	Potentiometer 2M 2W	R5
6	3	13730611	Knob	
7	1	672831	Switch Toggle SPDT	S4
	2	674216	Capacitor 0.02uf 1KDVC	C12,13
8	3	951474	Switch Seal	
9	1	951815	Light Amber 12 V	PL2
10	1	13792157	Lamp White 48 V	PL1
11	2	13730632	Potentiometer 10K 2W	R2, R4
12	1	950584	Knob	
13*	1	672786	Eyebolt, Lifting	
14	10	2133514	Hole Plug	
15	1	636702	Switch Toggle DPDT 3 Pos 15A	S3
16	1	992804	Potentiometer 250K 2W	R3
17	2	950122	Circuit Breaker 10	CB1, 2
18	1	952219	Receptacle, 110 V	J1
19	1	951916	Receptacle, 14-Pin	J2
20	1	58V75	Adaptor, B/A-WF x 1/4 NPTM	
21	1	954441	Warning Label, Shock AC	
22	1	2062171	Knob	
23	1	950510	Hose Nipple Barbed	
24	1	36066M	Box Gas/Water	
25	1	30612	Block, Molded Output	
26	1	954587	Overlay, Front Panel, Black, Heliarc 252 (was 952133 - gray)	
27	1	954589	Overlay, Front Panel, Black, Heliarc 352 (was 952154 - gray)	

\* Not factory assembled to the power source.

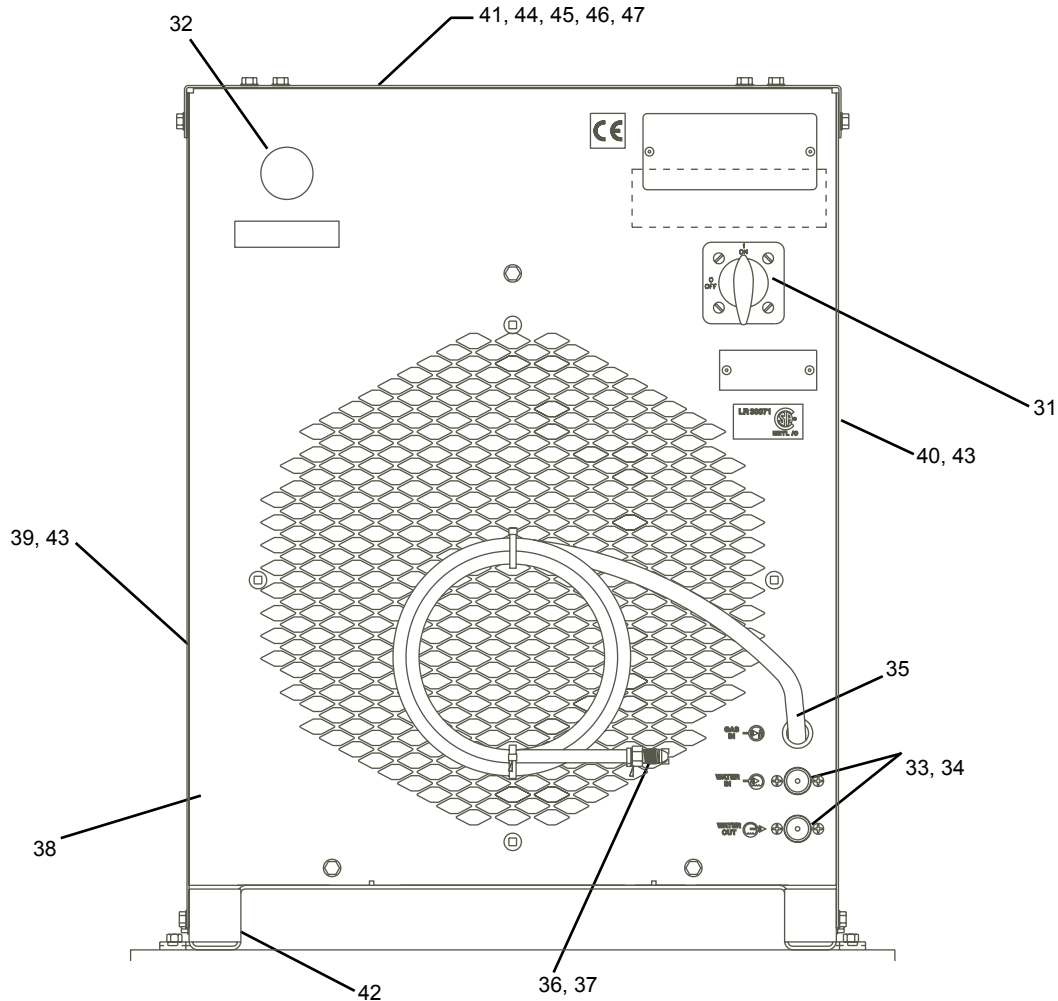


Fig. 6-2, Heliarc 252/352 Rear View

No.	Qty. Req.	Item No.	Circuit Description	Symbol
31	1	36107	Switch Power 600 V 63A (H 252)	S1
	1	950945	Switch Power 600 V 100A (H 352)	S1
32*	1	950219	Strain Relief	
33	2	58V75	Adaptor, B/A-WF x 1/4 NPT	
34	2	950510	Hose Nipple Barbed	
35	10 FT.	631F02	Hose, 1/4" ID	
36	1	11N22	Hose Nipple, B 3/16	
37	1	136Z08	Hose Nut B I/G	
38	1	36057M	Rear Panel Screened	
39	1	36052YL	Right Side Panel	
40	1	36045YL	Left Side Panel	
41	1	36046YL	Top Cover	
42	1	36035M	Base	
43	2	13734588	Decal, ESAB	
44	1	954008	Label, Danger High Voltage	
45	1	9512240	Label, Caution Lifting	
46	1	2091514	Label, Warning	
47	1	954564	Label, Schematic, 230/460 V, 60 Hz.	
		954597	Label, Schematic, 230/460/575 V, 60 Hz.	
		954585	Label, Schematic, 220/400 V, 50/60 Hz.	

\* Not factory assembled to the power source.

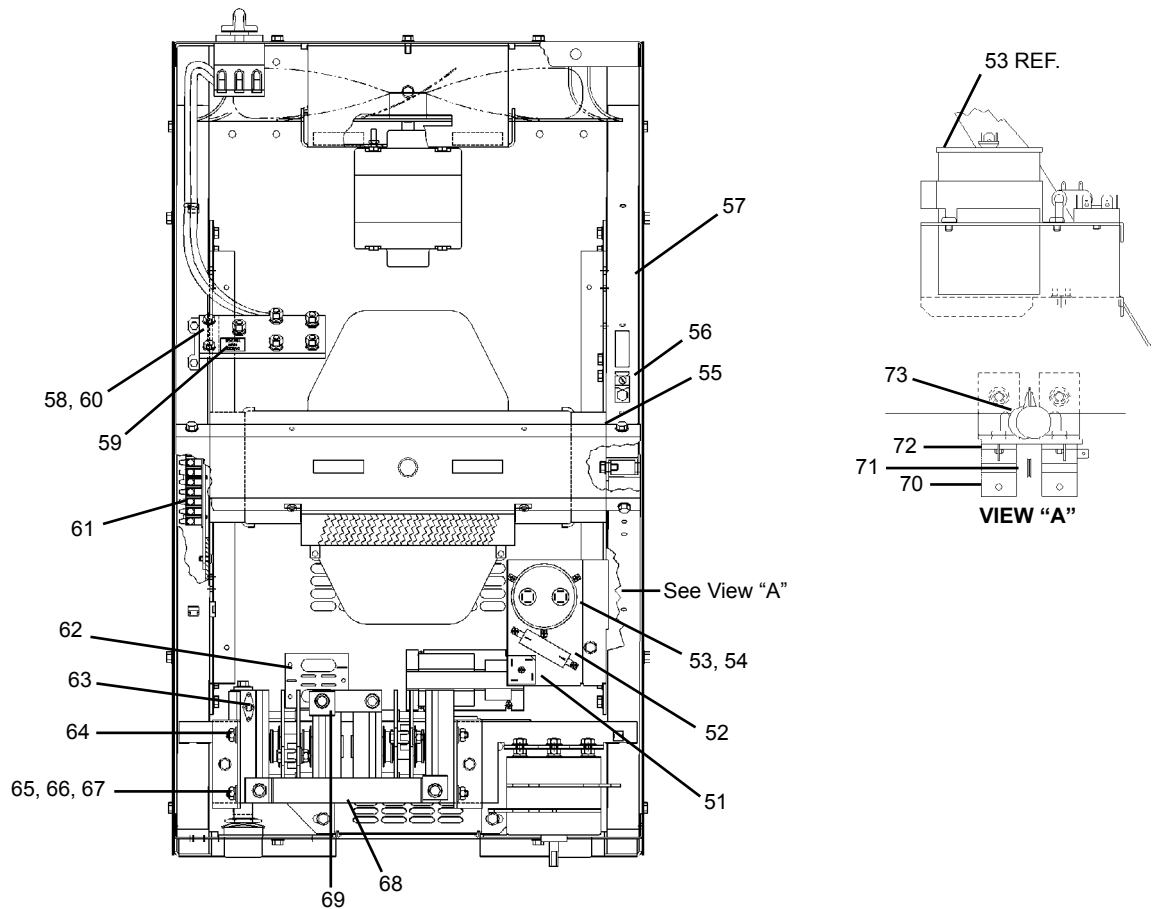


Fig. 6-3, Heliarc 252/352 Inside Top View

No.	Qty. Req.	Item No.	Circuit Description	Symbol
51	1	13730469	Bridge Diode	BR1
52	1	17240075	Resistor 25W	R6
53	1	950255	Capacitor. 60 $\mu$ f 370 Vac	C1
54	1	950254	Bracket Capacitor	
55	1	36049M	Lifting Bail	
56	1	647361	Lug, Term., Ground 2-8 Wire	GND1
57	4	36048M	Leg, A-Frame	
58	1	36132	Input Term. Board, 230/460 V	TB1
	1	32221	Input Term. Board, 230/460/575 V	
	1	32243	Input Term Board, 220/400 V, 50/60 Hz	
59	1	23604891	Label, Danger High Voltage	
60	1	36242	Filter Ass'y (50 Hz, CE Label Units Only)	C6, 7, 8
61	1	952073	Terminal Block, 12-Pos.	TB2
62	1	674971	Filter PC board Ass'y	PCB4
63	1	950710	Thermal Switch 12A, 120 V Q/D	TS1
64	1	38074	Snubber PC Board Ass'y	PCB2
65	1	36188	Angle Glastic Heatsink	
66	2	36191	Dual SCR Assembly	SCR1, 2, 3, 4
67	6	674216	Capacitor 0.02 $\mu$ f 1 KDVC	C2, 3, 4, 5, 9, 10
68	1	36185	Busbar Anode	
69	1	36186	Busbar Cathode	
70	2	673579	Heatsink, Spark Gap	
71	2	673578	Point, Spark Gap	
72	1	37246	Spark Gap Ass'y (Includes No. 70, 71, 73)	PCB3
73	2	951342	Capacitor CER 2500 PF, 15 KV	

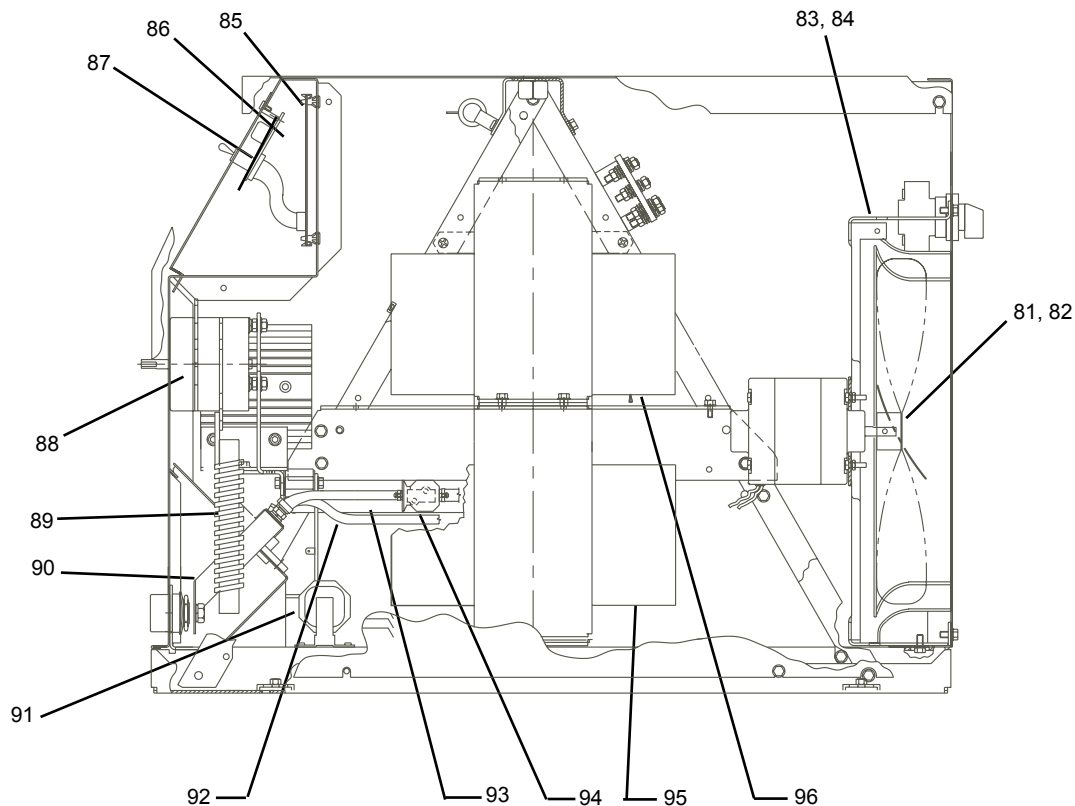


Fig. 6-4, Heliarc 252/352, Right Side View

No.	Qty. Req.	Item No.	Description	Circuit Symbol
81*	1	2062334	Fan Motor	M1
82*	1	36173	Fan Blade	
83	1	36043M	Fan Bracket	PCB1
84	1	13735508	Fan Shroud	
85	4	950708	Support, Board Locking	PCB5
86	1	38055	Control PC Board Ass'y (60 Hz)	
	1	38089	Control PC Board Ass'y (50 Hz)	S2
87	1	36226	Dig. Meter PC Board Ass'y (H 352; Opt. - H252)	
88	1	36176	Selector Switch	T3
89	1	36415	Air Core Transformer	
90	1	36187	Busbar Output	T2
91	1	951179	HI Freq. Transformer	
92	33"	997887	Hose 1/4" ID	SOL1
93	12"	997887	Hose 1/4" ID	
94	1	951634	Solenoid Valve 24 V	L1
95	1	36147	Inductor (H 252)	
	1	36142	Inductor (H 352)	L1
96	1	36150	Main Transformer (H 252, 230/460 V)	
	1	36148	Main Transformer (H 252, 230/460/575 V)	T1
	1	36149	Main Transformer (H 252, 220/400V 50/60 Hz)	
	1	36145	Main Transformer (H 352, 230/460 V)	T1
	1	36143	Main Transformer (H 352, 230/460/575 V)	
	1	36144	Main Transformer (H 352, 220/400 V 50/60 Hz)	T1

\* Original Hel. 252s used smaller 13730124 Fan Motor and 13730125 Fan Blade. See page 31.

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## NOTES

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## NOTES

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## NOTES

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## REVISION HISTORY

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### INSTRUCTION MANUAL CHANGES:

The "A" Edition (9/96) of this manual covers the following changes:

1. The 50Hz units originally designed for single 400V input power now have 220/400V input capability. Input Terminal Board 36218 was replaced by 32243 (No. 58 in Fig. 6-3).
2. 110V Receptacles 952219 replaced 951033 (No. 18 in Fig. 6-1).
3. Air Core Transformer 36415 replaced 680024 (No. 89 in Fig. 6-4).
4. Capacitors C9 and C10 were added (No. 67 in Fig. 6-3).

The "B" Edition (2/98) of this manual covers the following changes:

1. Added Section 4.1.6, Dip Switch Settings of Main Control Board Assembly (previously covered by an Insert dated May, 1997).
2. Clarified descriptions on the Contactor switch (S3) in the Operation and Troubleshooting sections.
3. Added S2 connections and J2 pin functions in all schematic diagrams.
4. Spark Gap Assembly, 37246, was made available as a replacement part instead of just individual parts (Fig. 6-3).
5. The Heliarc 252 power sources were equipped with small Fan Motor (13730124) and black plastic 4-bladed Fan Blade (13730125) up to late 1997. All power sources are now equipped with large Fan Motor (2062334) and 5-bladed metal Fan Blade (36173). The fan blades are not interchangeable but the large motor and fan blade combination can replace the small motor and fan blade combination.

The "C" Edition (5/99) of this manual covers the following changes:

1. The green/gray equipment originally designed for L-TEC is now obsolete and no longer available.
2. Changed the troubleshooting guide in section 5 to a table format.
3. Added two (2) .02uf 1kv capacitors (C12 & 13) across the S4 switch.

The "D" Edition (5/03) of this manual covers the following changes:

1. Updated the schematic diagrams and updated the format of the manual.

The "E" Edition (3/05) of this manual covers the following changes:

1. Revised gray items in Replacement Parts from "GY" to "M". Added black overlay part numbers.

The "F" Edition (2/06) of this manual covers the following change:

1. Revised Input Terminal Board configuration in Section 2, Installation.

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